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SETTING OF TUBULAR BOILERS

Foundations, Side-Walls, Lining and Methods of Suspension

There are many different methods of setting a tubular boiler, each of which may have its special advantages, depending upon the existing conditions and kind of fuel used, but whatever form of setting is adopted, the efficiency and life of a boiler will, to a greater or less extent, depend upon it. No matter

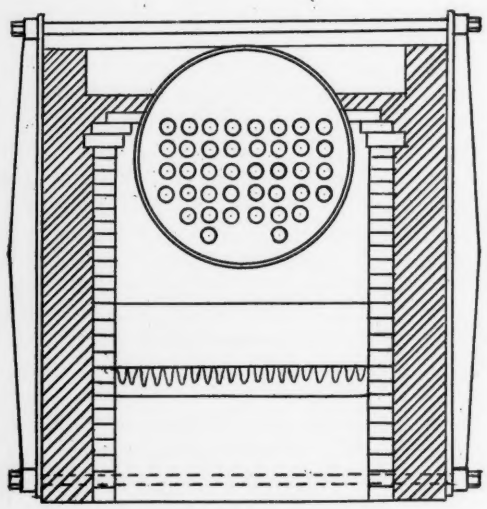

Fig. 1.

what kind of setting is used, however, there are certain conditions that must be fulfilled to produce the best results and it will be the object of this article to bring out some of these.

The first requisite for a good setting is a good foundation. If the ground is favorable, the foundation should have a depth of three or four feet below the level; and the first courses should be large stones carefully laid in cement. Upon this the walls can be built of either stone or brick to within half a foot of the floor level; above this, brick should be used. If the ground is soft, the excavation will have to be deeper, gravel, broken stone, etc., mixed with cement will have to be filled in, and the foundation built upon this bed.

The weight that may be put upon ordinary foundations for boilers should not exceed two thousand pounds per square foot as, the varying degrees of heat which affect a boiler setting and its liability to crack, a large part of the weight of the boiler might be concentrated upon a small portion of the foundation wall, which should therefore be of sufficient size to bear this weight without settling.

The distance that the under side of the boiler should be above the top of the grate varies with the kind of coal used. Anthracite coal requires the least distance and for horizontal tubular or flue boilers, this distance approximates 24 inches when large coal is used, and 20 inches when such sizes as pea, buckwheat and rice coal are used. For bituminous coal, the grates may be 30 inches below the shell for non-caking coals like Indiana block and varieties of the same kind, and 36 to 48 inches for gaseous coals. Thirty-six inches is considered a

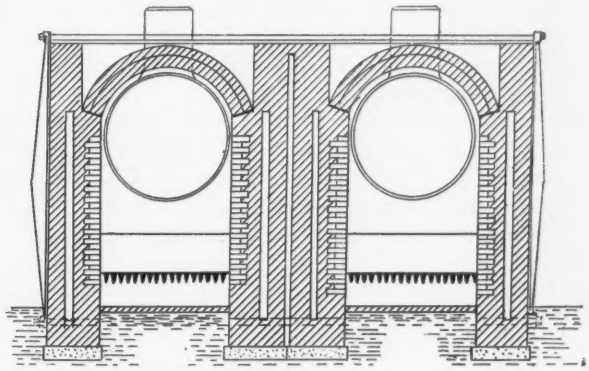

Fig. 2.

good distance for average bituminous coals. This gives all the space necessary to allow for a thorough mixing and combustion of the gases and unless forced, they can be fired almost smokeless. The height of the level of the grate surface above the boiler room floor is usually 24 inches, but is seldom ever higher than 26 inches.

The depth of the ash-pit is fixed by the height of the grate-surface above the fire room floor. This distance will generally approximate 20 inches clear space if the ash-pit floor be level, which is ordinarily the case. Sometimes the ash-pit floor inclines to the rear, making it deeper at the bridge wall than at the furnace front. With a long grate bar, this inclination makes an easier angle for the removal of ashes. The bottom of the ash-pit should have a tight brick or concrete floor.

The bridge wall must be strong enough to take the thrust of the implements used in cleaning the fires and must be thick enough so that the joints do not loosen by this action. The top of the bridge wall should not be less than 13½ inches

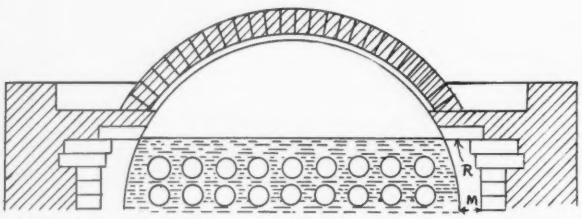

Fig. 3.

or 1½ bricks in thickness and never less than 18 inches thick where it receives the weight and thrust of the grate bars. The bridge wall should be faced next the fire and capped with fire bricks laid in fire clay. The top of the bridge wall is sometimes curved to follow the curve of the boiler, so as to present an equal area for the passage of the gases. This is altogether a matter of fancy, and no additional valuable results are had over that of building the bridge wall straight across the furnace. This latter has long been and is now the common practice in building bridge walls. It is customary to make a sloping surface from the top of the grates to the top of the bridge wall, but so far as effecting economy is concerned it make little difference whether this wall is straight or inclined.

Boilers should be set with as little brickwork in contact with the shell as practicable, particularly at and near the bottom where any water or moisture is liable to lodge against the plates. All the flues should be faced with fire bricks and should be sufficiently large to admit of being properly cleaned and to enable periodical external examinations to be made with facility and satisfaction. The slight waste in heat that may result from the use of moderately wide flues is far outweighed by the greater security obtained from the better examination they invite. The fact is too often lost sight of that the difficulty of cleaning the plates caused by the narrowness of the flues usually results in the plates becoming covered with a permanent covering of soot and other non-conducting substances which renders them useless as a heating surface and consequently the narrowing of the flues defeats its own intended end.

Steam boiler furnaces should be lined with fire brick at least as far back as the rear end of the bridge wall. This lining should be capable of repair or complete removal without disturbing the side walls. In making provision for relining a furnace with fire brick, one or two courses of fire brick headers should be used in finishing the top course of the lining, as shown in Fig. 1. This will permit the removal of the lower fire bricks without disturbing the upper courses in the wall. One thickness, 4 or 4½ inches, depending on the width of the brick, will suffice; these bricks should be set in fire-clay mortar. The fire-brick lining should begin at the bottom of the grate bars, and should include the stepped courses where the top of the furnace is enclosed up the side of the boiler, as shown in Fig. 1, which represents a wall extending vertically downward from the distance allowed at the top of the furnace for the hot gases to come into contact with the shell of the boiler near the water line. Whatever the shape of the furnace, the fire bricks should not be trimmed to fit the angle of the furnace sides, but should be used their full width and backed up by the red brick walls. The fire-brick lining between two boilers when set singly is carried out in the same manner as for the side walls.

The distance from the side of the boiler at its centre line to the side wall of furnace, as at M, Fig. 3, varies from 3 to 6 inches but 4 inches for all practical purposes is all that is needed. The under side of the top line of fire bricks where they join the boiler, as at R, should not be much higher than the upper line of tubes. If this distance were extended above the water level there would be danger of burning the boiler along that line, especially when forcing the fire before steam was raised in the boiler.

For single walls, the thickness should not be less than 2 bricks, varying from 17 to 18 inches, depending on the size of the brick and this must be exclusive of any fire-brick lining subject to renewal. The thickness of the walls between two boilers ought not to be in any case less than 1½ bricks or 13 inches, to which must be added the two fire-brick linings of 4 or 4½ inches each, making the wall at least 21 or 22 inches in width, as shown in Fig. 2.

A considerable economy can be effected by building the furnace walls double with an air space between the inner and outer walls, as shown in Fig. 2. Walls thus constructed prevent radiation of heat. When constructing hollow walls headers should extend occasionally about every 2 feet, to give support to the walls and prevent the air space closing up. These headers should merely touch but in no case enter or be fastened to the opposite wall. The width of the air space may be from

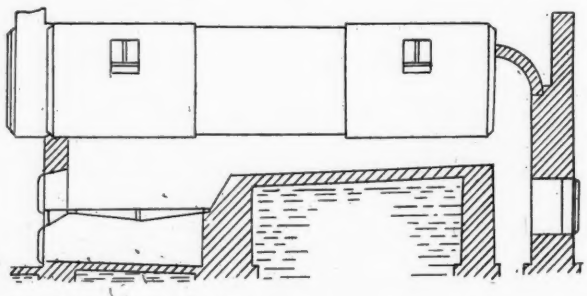

Fig. 4.

3 inches for small boilers to 4 inches for large boilers. This applies to the air space in division walls as well as outer walls. The rear wall of the setting should have an air space as well as the side walls.

Nearly all furnaces for steam boilers are constructed of red brick. These should be quite hard, so as to produce a ringing sound when struck; they must be flat square to each other and of uniform size and color. The sizes vary for different localities but will average not far from 8⅜ x 4⅛ x 2¼ inches

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each. The harder the brick, the less water it will absorb and the greater will be its ability for carrying a heavy load. Buff or salmon brick which have not been burnt sufficiently should not be used. The thickness of mortar joints will approximate ¼ inch, so that the average height of four courses of common brick is 10 inches. The mortar used for boiler setting should have a small proportion of cement added to it in the proportion of three parts of good lime mortar with one part of cement mortar. The sand used in the mortar should be clean and

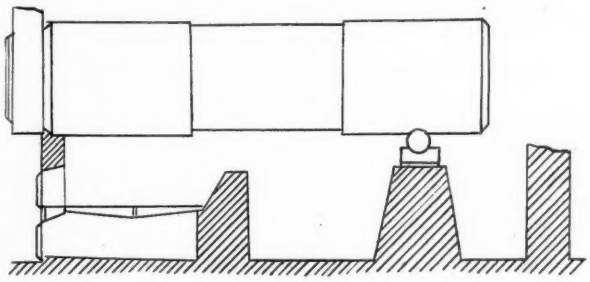


Fig. 5.

sharp. Fire bricks should be laid only in fire clay. Arch bricks should be carefully fitted dry and when the arch is completed the bricks should be set with a thin fire-clay paste. The sizes of fire brick vary with the locality, but they are usually larger than red bricks.

When boiler settings are new the walls will crack more or less, as a rule, and when these cracks are large enough to allow a leakage of air into the furnace a loss of efficiency ensues, and it is a matter of economy, therefore, to construct the walls at the outset in the best manner possible. The cracking of any brick wall which is subjected to heat on one side and cold on the other, cannot be entirely prevented. When the furnace walls begin to open, the joints should be grouted with a thin fire clay, which will prevent the admission of cold air through the walls of the furnace. To prevent the walls from spreading, cast-iron buckstaves are commonly used connected together by stay-rods which extend through from side to side, as shown in Fig. 1. To prevent the buckstaves from bending, they are ribbed through the centre to the depth of from 4 to 6 inches. They are usually placed 4 to 5 feet apart on the side walls.

The space back of the bridge wall is known as the combustion chamber. This space is supposed to be useful as a reservoir for the heated gases, but tests upon boilers have shown that it is immaterial whether a combustion chamber is provided or not. For this reason and from the fact that the side walls of the combustion chamber must necessarily radiate heat, it is usual to fill in the combustion chamber with earth, as shown in Fig. 4, leaving room enough at the rear end for a cleaning door for taking out the ashes which accumulate there.

The usual methods of supporting tubular boilers are by means of brackets riveted to the sides of the shell and resting on iron plates imbedded in the side walls, the back end being very often upon rollers and free to move with the expansion and contraction of the shell due to variations in temperature, or, the rear end rests upon a single plate or roller supported by a central pier placed directly beneath the boiler; or, they are suspended from overhead cross-girders whose ends rest either upon side walls or upon columns disconnected entirely from the setting.

A very common arrangement of suspension is by means of sole plates only, but on account of its not allowing the boiler to "breathe," it is not now generally used for the back support. With the sole plate arrangement the weight of the boiler is carried by the side walls, the lugs resting on cast-iron plates upon which the lugs are expected to slide when the shell expands and contracts. The friction of the lugs is usually so great, however, that the expanding shell tends to push the walls outward and causes cracks and air leaks which seriously impair the economy of the boiler. When the side brackets are used, rollers should be placed between the bracket and sole plate to reduce the friction and thus prevent straining the walls.

If the side walls sustain the entire weight, care should be exercised in building the walls and in keeping them in good condition afterward, for should the boiler settle to any extent, severe strains would be produced in the boiler itself and in the setting and the probability is that the joints in the steam pipes near the boiler would suffer. When the weight of the boiler is very great or if its length exceed, say, 20 feet, it would be better to suspend the boiler from cross beams resting on side walls or, what is better, upon iron columns or piers of masonry disconnected altogether from the setting. The extra expense of this method will be more than repaid by the safety from the liability of the boilers changing their position and breaking their backs.

Where the weight and length of the boiler require but two points of support on each side, these should be placed about one-fifth the length of the boiler from each end or tube sheet. With long cylindrical boilers the hangers should be so arranged that the load will be evenly distributed and the boiler free to "breathe" easily under all conditions of temperature.

The upper part of the boiler is frequently left exposed to the atmosphere but it should be covered with some form of insulating material which is easily removable. Whether the

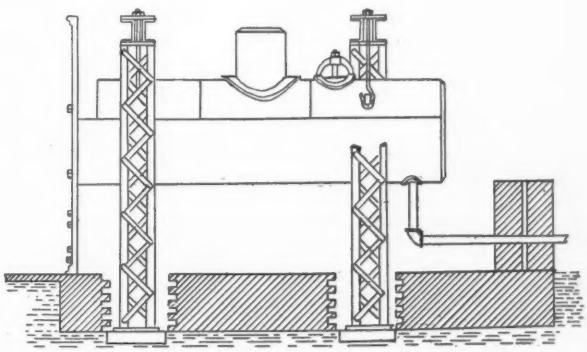


Fig. 6.

flue gases should ever be allowed to strike the boiler above the water line is a question which is in dispute. One authority claims that under no circumstances should the fire line be carried above the water level. "Never expose to the fire or gases of combustion any part of the shell not completely covered with water" is his motto, as hundreds of boilers have been seriously injured and many ruined by arching over the top in order to form a conduit for the hot gases. It is claimed by some advocates of this method that a greater amount of heating surface is obtained, while others state that this tends to superheat the steam.

Those, who do not favor the passing of the flue gases over the boiler, state that even if it were possible to superheat the steam when in contact with a large body of water, as in the steam space of a boiler, the superheating would not be appreciable with a well-proportioned boiler, as the temperature of the escaping gases in the arched flue ought not to greatly exceed the temperature of the steam. If the temperature of the flue gases does greatly exceed that of the steam, the effect on the steam after running the boiler several weeks is insignificant, as the heat is prevented from acting on the boiler and its contents by the accumulation of soot and ashes on the top of the shell. They state that its advantages are therefore questionable even under the most favorable conditions, while the disadvantage of allowing the flue gases to strike the boiler above the water line is often serious.

On the other hand, other authorities claim that the overheating of the top sheets has never occurred nor ought it to be expected, in any properly designed boiler setting not using a powerful fan blast. The reasons given are that no injury could accrue to the shell at a temperature below red heat (900° Fahr.), and it is scarcely possible that any such temperature or more than half of it ever reaches the top portion of the shell of a boiler not under steam. In any boiler setting in which there is a ratio of 30 square feet of heating surface to one square foot of grate surface, employing a natural draft, there is probably no danger whatever that the top of the sheets will ever become overheated.

Following the latter suggestion, boilers are set with a brick arch over the top of the boiler, entirely encasing it, with an air space between the arch and the shell. With this arrangement the products of combustion from the grate pass along the under side of the boiler to the rear, then return through the tubes to the front, and thence back again, along and over the top sheets of the boiler shell to the rear, where they are finally conducted to the chimney.

A setting that is very much used is shown in Fig. 5. The forward end of the shell rests on the boiler front while the rear end is supported by a roller resting upon a sole plate

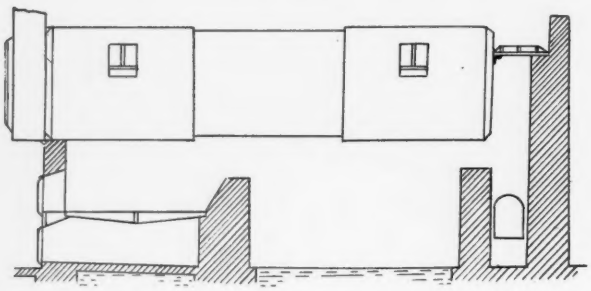


Fig. 7.

which is supported by a brick pier. Instead of a roller, sometimes a plain cast-iron plate is used. With this kind of setting the boiler is free to expand in both a longitudinal and a transverse direction without any strain coming upon the boiler, as the shell does not at any point come into contact with the walls. The pier is placed about one-sixth the length of the boiler from the rear and is built very similar to an engine foundation. The boiler is enclosed at the top with an arch, as shown in Fig. 3, with an uptake in the rear; the products of combustion after passing through the tubes return along the top of the boiler to the chimney.

An arrangement which from every standpoint is considered to be the best form of supporting a boiler is shown in Fig. 6. The weight of the boiler is borne by four posts or columns built of iron or steel. The boiler at the rear is supported by two rods which are connected to the boiler by means of two eyes riveted to the sides of the boiler, the other ends of the rods being supported by the horizontal channels which bridge

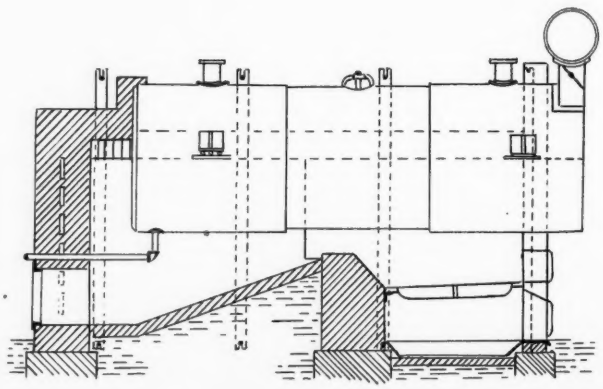


Fig. 8.

the posts. The single suspension rod at the front is attached to the boiler and to the horizontal channels in a like manner. In this case the boiler is suspended free not only of the setting but of the boiler front as well.

Boilers are usually supported on the rear wall either by a plate connection or an arch connection, shown in Figs. 4 and 7. The arched connection at the rear of the boiler is made up of cast-iron segments filled in with fire brick and afterward with earth to make it air-tight. The back plate affords easy access to the end of the boiler. Either of the two is considered good, but the covering of the joints should not be neglected or cold draughts of air at that point will lower the temperature of the gases passing through the tubes.

A setting that is recommended by the Hartford Steam Boiler Inspection and Insurance Co. is shown in Fig. 8. The front brackets rest upon sole plates, while the rear brackets rest upon rollers to allow for expansion, the rear of the boiler being set one inch lower than the front. The grates are inclined so that they are three inches lower at the bridge wall than at the furnace door, so that when the fires are level, as they should always be, they will be thicker at the back end, where the draft is strongest and the consumption of fuel most rapid. The side walls of the furnace slope outward with a batter that is sufficient to keep the walls three inches from the shell at the centre line of the boiler. The conduction of heat through the settings is checked by a two-inch air space in the outside walls. The space back of the bridge wall is filled in at an inclination and afterward covered with brick. A cleaning door is shown at the rear of the boiler wall. The ash-pit is cemented to a depth of 6 inches below the level.

The practical considerations that determine the size of the grate are the diameter of the boiler, which determines the width of the furnace, and the impossibility of keeping the fires clean at the bridge wall if the grates exceed 7 feet,

establishes the maximum limit of length in hand firing. For horizontal boilers it is customary to set the side walls 4 inches away from the boiler, as at M, Fig. 3. If brought vertically down, as shown in Fig. 1, the maximum width of the furnace will be had, but ordinarily the least width is about the diameter of the boiler which is obtained by slanting the furnace walls from the centre line of boiler to the grate.

For horizontal tubular boilers, one thirty-fifth of the total heating surface will make a good average area for the grate surface or eight times the area of all the tubes will approximate good working conditions.

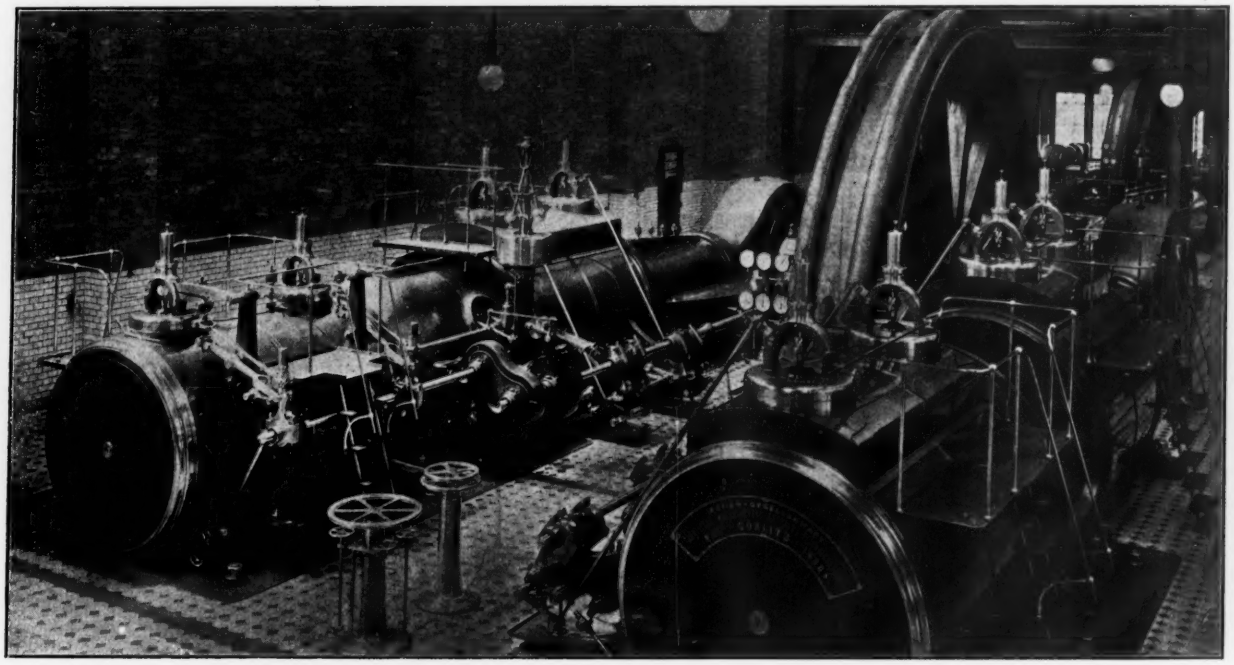
Grate bars are usually made out of cast-iron of various forms depending upon the kind of fuel to be burnt. They should rest upon proper supports such as iron strips imbedded in the sides and ends of the furnaces with enough metal protruding from the wall to form a support, or by angle irons secured by bolts imbedded in the walls or by tee irons partly imbedded in the walls. Whatever the form of support they should be of such form, dimensions and so located under the grate as to prevent their warping or getting out of shape by the heat from the fire. The grates should have at least one end free for expansion or they will get out of shape. Shaking and dumping grates require no wall supports, the grates having a frame with legs which rest on the floor of the ash-pit.

BERLIN LIGHT AND POWER PLANTS

By Frank C. Perkins.

Berlin has a population of about two millions and is exceedingly well equipped with electric light, power and railway stations, the total capacity of the lighting and power plants being but a trifle less than 100,000 horse power. Alternating current as well as direct current systems are employed, the latter being connected with storage battery installations for regulation and taking care of the peak of the load at various sub-stations, the distribution being on the three-wire system.

The current from this station supplies directly, from the



One of the 4000 H. P. Horizontal Engines in the Oberspree Power Plant, Berlin, Germany.

The Oberspree plant shown in the accompanying illustration has a total capacity of over 13,000 kilowatts, the three-phase alternating current being generated at this station. The largest units shown in the illustration are of the horizontal tandem high speed type of 4000 horse power capacity. Each unit operates at from 83 to 87 revolutions per minute at a steam pressure of 210 pounds per square inch. Two of the units have a capacity of 2300 horse power. These engines are of the triple expansion vertical type running at a speed of 107 revolutions per minute, the engines being supplied with steam at a pressure of 180 pounds. The three-phase alternators are directly connected, one on each side of the vertical engine. A small fly-wheel is utilized in connection with the electrical generator to aid in the speed regulation, it being mounted between the alternator and engine.

three-phase distribution line, 14,000 incandescent lamps of 50 watts each and 1314 arc lamps of 10 amperes each, while the motor circuits supply current to machines having a total capacity of 9540 horse power. The Oberspree plant also supplies current to two sub-stations, one at Marianenstrasse and one at Pallisadenstrasse, the former having a total output of 7304 kilowatts and the latter, 2904 kilowatts. These sub-stations distribute direct current on the three-wire system

at 220 volts and street railway current at 500 volts. The larger sub-station has a storage battery plant for reserve of 1465 kilowatts while the accumulator plant of the smaller sub-station has a capacity of 732 kilowatts. They supply current to 18,360 and 7620 incandescent lamps respectively of 50 watts each. The commercial arc lamps served from these two sub-stations number 980 and 450 respectively of 10 amperes each. The motors used for commercial purposes in Berlin operated from the Marianenstrasse sub-station have a total output of 5578 horse power while those supplied with the current from the Pallisadenstrasse sub-station develop 1991 horse power.

In the same way, a number of sub-stations are supplied with the phase current from the Moabit power station, which has a capacity of 9000 kilowatts. The Voltastrasse sub-station has an output of 5368 kilowatts while the Wilhelmshavenstrasse sub-station is equipped with apparatus having a total output of 1936 kilowatts. There are 96,000 incandescent lamps operated from the Konigin-Augustastrasse sub-station alone, the latter having a storage battery plant of 1880 kilowatts.

The total capacity of the various storage battery plants used in the sub-stations and power house of the Berliner Elektricitatswerke is 13,742 kilowatts and the central stations of the city supply the necessary current for lighting nearly half a million incandescent lamps of 50 watts each; while the arc lighting service of the city is supplied with current for 15,683 arc lamps of 10 amperes each. Electric motors are quite extensively used for factories and other business places in Berlin, the total power developed by the electric motors being 38,409 horse power.

In the Oberspree power station there are, in addition to the vertical engines, a number of triple expansion compound engines of the horizontal type. At the Centrale am Schiffebauerdamm there are in operation two vertical compound engines of the Gorlitz type, operating at a steam pressure of 150 pounds and developing from 1500 to 2000 horse power at a speed of 105 revolutions per minute. Until recently the horizontal reciprocating engine seemed to be the favorite with German engineers for central power stations, but a large number of the vertical type of engines are now in operation, which have given excellent satisfaction.

There are in operation in the city of Berlin a large number of direct-current machines of the inner pole type constructed by Siemens & Halske although this type of machine is not extensively employed in the latest plants. At the Berlin-Pankow generating room there are two Siemens & Halske inner pole generators operated by horizontal compound high speed engines while at the Gladbach power plant, shown on the cover illustration, there are three tandem compound horizontal engines directly coupled to Siemens & Halske direct-current machines, an additional fly-wheel of large diameter being employed for aiding in the regulation. The Berlin power plant of the Allegemeine Elektricitets Gesellschaft is equipped with triple expansion horizontal engines directly connected to revolving field alternators.

While the steam turbine is now being introduced into Germany and other European countries extensively in sizes up to 5000 kilowatts and even larger and the steam consumption is very low, still many prominent engineers are doubtful as to the ultimate triumph of the steam turbine over the reciprocating steam engine. At the Frankfort Central station, a Parsons steam turbine, directly connected to a three-phase alternator, supplies 2295 kilowatts with a steam pressure of 160 pounds and a superheat of 312 degrees centigrade, the steam consumption being only 14.75 pounds per kilowatt hour. This is a very high efficiency and the steam turbine is rightly receiving the attention of steam engineers throughout the world, as even larger units have shown still greater economy. While the steam turbine has the advantage of the reciprocating engine in the amount of floor space required, it is claimed that this is largely offset as well as the low first cost of the turbo-alternator by the larger capacity required for the auxiliary installation, including condensers, superheaters and their accessories. It is also claimed by eminent authorities on the reciprocating steam engine who doubt the superiority of the steam turbine that the wear on the steam turbine blades of the turbine is excessive through wire drawing at the clearances and that the maintenance really exceeds that of the reciprocating steam engine.

The high power gas engine is now competing successfully with the reciprocating steam engine for central station work and on account of its high thermal efficiency and the possibility of utilizing waste blast furnace gases direct, the internal combustion engine is being employed largely in iron and steel plants in the power house where heretofore reciprocating steam engines supplied with steam from boilers fired by the waste gases were employed.

Keeping a Dynamo in Good Order.

The dynamo must be kept clean like any other machine and when not in use should be kept covered. Copper dust, which is the result of the friction between the brushes and commutator, should be cleaned off the armature and field with a brush and a pair of bellows regularly. Shafts and pulleys running near the dynamo must be prevented from throwing oil on the dynamo, especially the commutator. Brushes should never be lifted off the commutator when the dynamo is running with load. Binding posts and other contacts should be examined frequently and tightened when necessary.

When a short-circuit or overheating occurs in the armature, the burnt coils effected must be taken out and replaced. Overheating of the armature coils is often caused by the short-circuiting of two or more segments of the commutator by means of copper dust which has been allowed to settle at the back of the commutator, or by excessive sparking of the brushes, forming little bridges of metal across to adjacent commutator segments.

The faults which mostly occur in field magnets consist in short-circuiting coils, or getting parts of the field wire in contact with the iron core. The field wire should be unwound until the damaged parts are reached and after insulating it properly, it should be wound back on the core. The rewinding can best be done by hand if only a small amount of wire is taken off, but a lathe is the handiest machine on which to do the unwinding and rewinding if considerable wire is taken off.

To Determine Length of Belt.

When it is not convenient to measure with a tape line the length required, as for instance, before the shafting is erected, add the diameters of the two pulleys together and divide the result by 2, and multiply the quotient by 3¼; add the product to twice the distance between the centres of the shafts and you have practically the length of belt required.

SADDLE, FLAT, SUNK AND FEATHER KEYS

Some Different Kinds of Keys for Resisting Torsion

When a pulley or fly-wheel is put upon a shaft, there must be some means of fixing it there so tightly as to keep it from turning on the shaft under the influence of torsion. There are a number of ways of accomplishing this end. Set screws are sometimes put in the hub and screwed so as to jam against the shaft. The objection to this method is that it spoils the shafting and will not stand a large twisting moment. Another method is to put a taper pin diametrically through the hub and shaft, which, while capable of resisting a large amount of torsion, is apt to weaken the shaft. Large wheels are forced upon shafts by means of hydraulic pressure and in some cases expanded bushings are used, but by far the most common method of fastening a hub and a shaft together is by the use of keys.

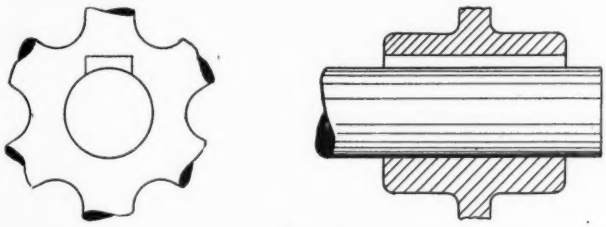


Fig. 1.

A key is a wedge of iron or steel, generally rectangular in section, though square and round keys are used for special purposes. Steel is the best material for ordinary keys although wrought-iron is often used.

The saddle or hollow key is shown in Fig. 1. It fits into a rectangular recess in the hub and is shaped to fit the surface of the shaft. With this form of key it is not necessary to cut the shaft in any way and as it depends solely upon friction, its holding power is small and consequently only useful for light work.

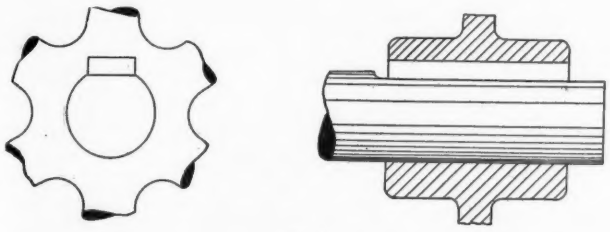


Fig. 2.

The flat key shown in Fig. 2 receives its name from the fact that it rests on a flat which is formed on the shaft to receive it. The holding power of this form of key while not very great is much greater than the saddle-key form.

The most common form of key is the sunk key, shown in Fig. 3, which fits into grooves in both the pulley and shaft. The resistance it offers in turning is equal to the force that it would take to shear it off when in position. The usual method of placing a key is to put the pulley or wheel in place and drive the key in. But if the key is a sunk one, then the shaft must be key-seated for a distance beyond the hub so as to allow the key to be inserted. Very often another method must be resorted to, for to run the keyway any longer than the hub would be objectionable. To avoid it, the keyway is cut, the key fitted in the shaft and the wheel finally driven over the shaft and key. Where driving is not permissible, the key is put in position, the wheel slid over the key, which is then locked by one or more set screws.

When the torque is very great, several keys are better to use than one large one, as the size of one large keyway would greatly weaken the shaft. When two keys are used they are usually set at right angles to each other so that their combined area will give the strength necessary to resist shearing. Very often a saddle key is used in conjunction with a sunk key to keep the wheel tight. This sometimes is necessary when the hub is not a good fit on the shaft. The sunk key will transmit the turning moment while the saddle key will hold the wheel tight and prevent its rocking on the shaft.

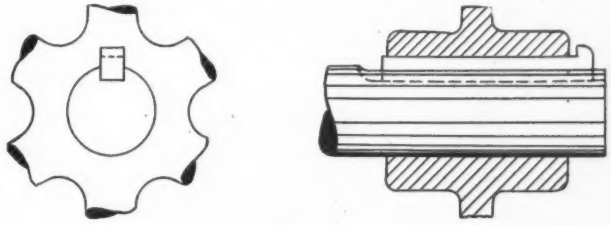


Fig. 3.

When a hub is shrunk on a shaft it is usual to take further precaution to prevent the surfaces from slipping on each other, by using a round key, which is often nothing more than a piece of stout steel wire. A hole is drilled parallel to the shaft, half in the shaft and half in the hub, into which is forced a round pin which serves as the key.

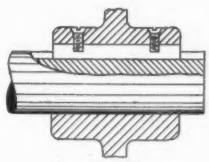


Fig. 4.

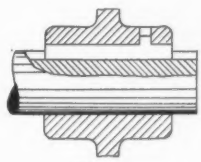


Fig. 5.

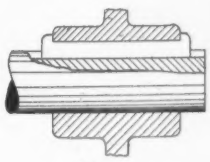


Fig. 6.

Where a key does not extend from side to side of the hub, or if but one end of it is accessible, some means must be provided so that it can be withdrawn in case of necessity. This is usually accomplished by making a head on the end, called a gib-head, as shown in Fig. 3.

Very often it is desirable to have the wheel turn the shaft, but at the same time allow a relative motion in the direction of the shaft. The form of key which allows this is called a feather key. This form of key has no taper and, of course, must not fit tight in both hub and keyway. When the key is fastened to the hub, the key should not be much longer than the hub so that it can be moved sidewise, but when the key is

fastened to the shaft, the key must be as long as the travel of the wheel in a longitudinal direction. Fig. 4 shows a feather key attached to the hub by means of set screws. Fig. 5 shows a key which has a projection on it, which projection enters a corresponding hole in the hub of the wheel. Fig. 6 shows a feather key with gib ends which answer the same purpose as the projection shown in Fig. 5.

In working out the formula for the strength of keys and giving due consideration to the practical points involved it has been found that the following sizes of keys give results which are satisfactory for flat keys, which not only resist torsion but also prevent endwise movement:

Dimensions of Flat Keys, in Inches.

Diam. of Shaft.	Breadth of Key.	Depth of Key.
1	1-4	5-32
1 1-4	5-16	3-16
1 1-2	3-8	1-4
1 3-4	7-16	9-32
2	1-2	5-16
2 1-2	5-8	3-8
3	3-4	7-16
3 1-2	7-8	1-2
4	1	5-8
5	1 1-8	11-16
6	1 3-8	13-16
7	1 1-2	7-8
8	1 3-4	1

When square keys are used, the breadth and depth of the key can be made approximately one-fourth the diameter of the shaft. The dimensions of sliding feather keys follow the dimensions in the above table except that they are made with the dimensions reversed, the width of a feather key corresponding to the depth of a flat key and the depth of a feather key being the same as the breadth of a fixed key for the same diameter of shaft.

The best positon for a key, when an arrangement such as a crank is being keyed on, is in line with and between the centres of the shaft and crank pin. Great care should be taken that the sides of the key fit the keyway perfectly and that these sides be perfectly parallel, not taper. The very slight taper given to a key should be at the top. The objection to tapering a key is the undue strains which a wedge of that character often brings upon the pieces to be fitted together and there is no means of knowing when the wedge is driven home whether it is well fitted or not. For very careful and accurate work, keys should be made a driving fit without any taper.

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Hot Bearings and Their Treatment.

By James E. Noble.

Some time ago, I noticed a question which was asked by a man signing himself, "An Engineer." The question read: "What is the cause of the bearing on the connecting shaft of an engine getting hot on the crank end?" Now this was a very poor way to go looking for information, as no proper information as to any of the conditions existing was given, nevertheless several of the probable reasons were given him but there was a great deal left unsaid. In case there may be another hot bearing somewhere in this wide world, a list of most of the causes that are liable to bring about that most undesirable condition will not be out of place. (1) Springing or shifting of pedestal or pillow block. (2) External heat. (3) Journals too small in diameter or length. (4) Engine out of alignment. (5) Springing of headplate. (6) Overloaded engine. (7) Brasses pinching the journal at their edge. (8) Brasses set up too tightly. (9) Warped and cracked brasses. (10) Newly-fitted brasses and journals. (11) Grit from any source in the bearings. (12) Not enough oil. (13) Imperfectly fitted brasses. (14) Oil squeezed out of bearings. (15) Brasses too loose. (16) Oil feed stopped. (17) Dirty or poor oil. (18) Refitted-brasses or journals, and there may be more.

An engine bearing should approximate as nearly as possible a hole through a solid support. Of course, a bearing will wear, so some means of adjusting the brasses is necessary. Many claim that it is a mistake to make bearings adjustable as it gives careless men an opportunity to do mischief, and I am sorry to say that there is a lot of truth in the statement, for I have known men who, as soon as they heard a noise or pound about an engine, immediately started to tighten up this or that bearing. This habit, which is not general, thank goodness, is to be deplored. It should be the object of the engineer to get his engine in perfect line and properly adjusted, when it will run smoothly and noiselessly for months without the use of the hammer or wrench. If a bearing shows an inclination to heat, see that the oil tubes are clear and if more oil fails to reduce the heat, a mixture of oil and flake graphite or powdered soapstone may help reduce the friction. A little aqua ammonia run into a hot bearing sometimes helps, as it converts the oil into soap, and soap is a good lubricant. Mineral oil will not saponify, so the ammonia would be of no use if that kind of oil was being used. If the bearing continues to get hotter after trying these remedies, it would be wise to stop the engine, otherwise the brasses and journal may get so badly cut that the engine will have to be laid up to be repaired. There are other things that can be tried, as for instance, keeping a constant stream of water on the bearing, if they are not too hot to use that plan, but in any case the water is apt to warp or crack the brasses by unequal contraction. If it is at all possible, the best thing to do when a bearing gets hot is to stop the engine and slack back the key or cap nuts, cool the brasses if in a desperate hurry, but let them cool naturally, if you can, as it is by far the best way. When brasses are babbitted the chances are that if allowed to get very hot they will run, which means that another set will have to be used or new babbitt run in. The journal should be examined to see that it has not been grooved while hot and, if it has, it should be attended to as well as the brasses.

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There has been recently erected at Milwaukee what is said to be the largest elevated steel water tank ever built for a private concern. The tank is 22 feet in diameter and 28 feet high, and will hold 100,000 gallons of water. A 10-inch pipe connects the tank with sprinkler pipes. A steel coil encircles the superstructure, and jets of steam can be forced into the tank from the boiler house in the winter to prevent freezing. Its extreme height is 164 feet above the ground level, added to the 148-foot elevation of the plant itself, makes the new structure visible for miles in all directions.

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The area of the air passages through grate-bars is usually from 30 to 50 per cent. of the area of the grate.

A LONDON CENTRAL STATION UNIT

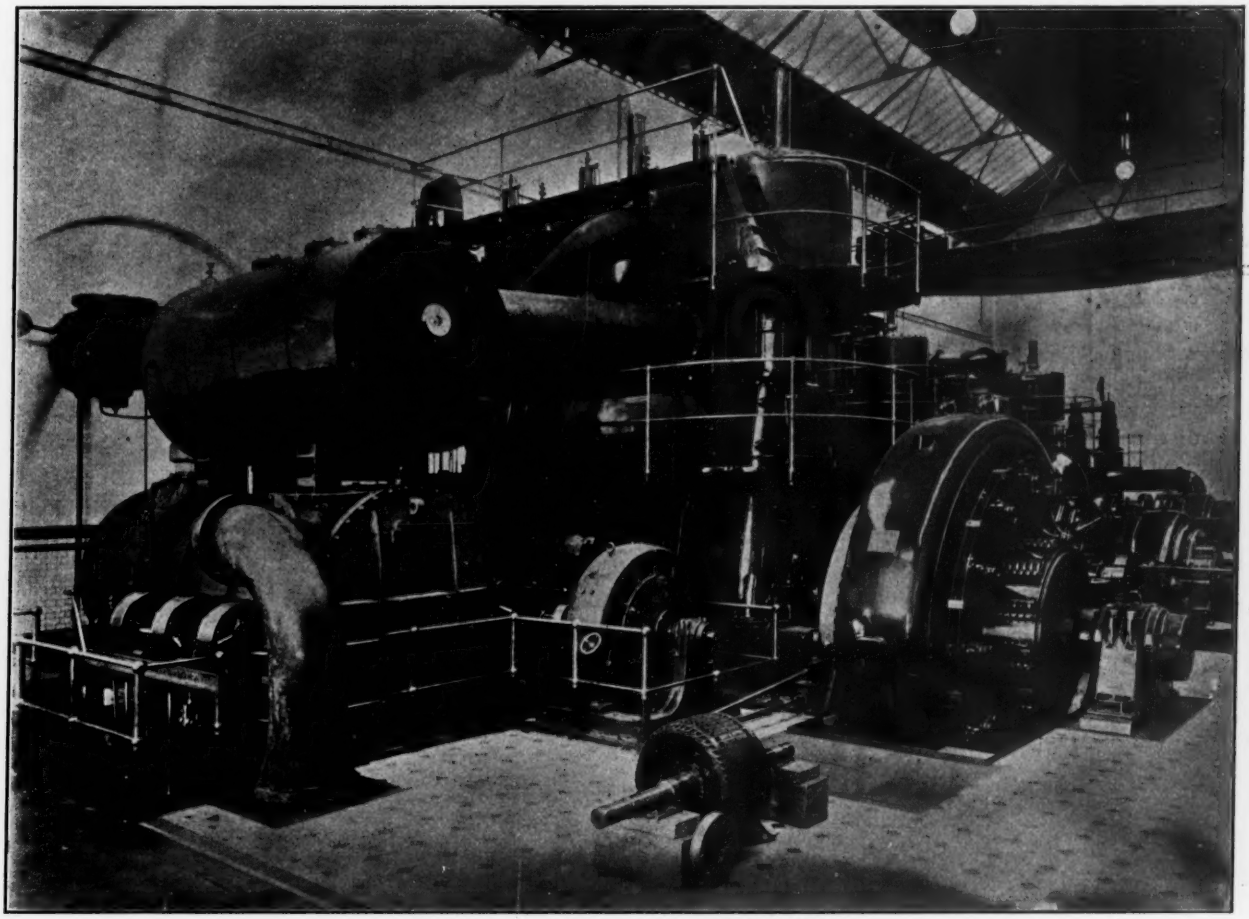
Recent Enlargement of the Output of the Hackney Generating Station

By E. Guarini.

One of the most important municipal electrical undertakings in the County of London is that which was inaugurated by the metropolitan Borough of Hackney, in November, 1901. The supply is given on the direct current system at 240 volts. Recent extensions were rendered necessary by the load, which increases each day. A new generating set has, in fact, been recently installed, as shown in the accompanying illustration, and consists of a Belliss engine of the standard type of this firm, capable of giving 2150 British horse power at normal load and 2650 British horse power at maximum load when running at 165 revolutions per minute, with a steam pressure of 175 pounds at the stop valve, coupled direct to a 1500 kilowatt dynamo, supplied by the British Westinghouse Electric and Manufacturing Co., Ltd. As the steam pressure varies up to 225 pounds per square inch at times, owing to the use of the destructor added to the plant, the engine has to accommodate itself to this variation, without adjustment of the governors, and will work continuously at the higher pressure.

The generator is a 10-pole machine of the latest pattern, and has a normal full load capacity of 1500 kilowatts, at 490 to 560 volts, this machine unlike the others, being connected between the outers of the three wire system. The combined weight of the engine and dynamo, including the fly-wheel, is 121 tons, and the over-all height is 19 feet, the diameter of the crank shaft is 9¾ inches, while that of the generator is from 18 to 22 inches. The addition of this generating set, which occupies a floor space of 32 feet, 6 inches by 15 feet, 8 inches, has practically doubled the output of the station.

The set is associated with a condensing plant, which consists of a large oil separator and a surface condenser, with air and circulating pumps. The oil separator consists of a cylindrical shell fitted with baffle-plates. The condenser has a cooling surface of about 4500 square feet, and occupies a floor space of some 15 feet by 6 feet 6 inches. The three-throw air pump is of Edwards type, with barrels 15 inches in diameter, stroke 8 inches. It is driven direct by a six-pole Westinghouse motor of 56 horse power at 160 revolutions per minute. The three-throw double acting circulating pump has a capacity of 200



1500 K. W. Condensing Unit at the Hackney Power Station, London, England.

gallons per minute, with barrels 13 inches in diameter and a stroke of 10 inches, it is driven from the same motor as the air-pump by two Reynolds roller chains, at a speed of 87 revolutions per minute. The complete plant is capable of dealing with a maximum of 40,000 pounds of steam per hour; up to 30,000 pounds per hour a vacuum of 27 inches is expected, with circulating water at 79° Fahrenheit. A small pump driven by an eccentric on the end of the shaft of the circulating pump sends the oil from the separator to a settling tank, whence oil can be drawn off for rough purposes, the water being drained away by a cock. Used lubricating oil from the engine crank chambers is taken to a settling tank, and afterward pumped into filters. At present, cooling water for the condensing plant is obtained from a reservoir surmounted by a cooling tower, of the open type, capable of dealing with 2000 horse power. Make-up water for the cooling pond is obtained from a surface well by means of a 3-inch centrifugal pump.

There Are Others Like This.

By C. W. Dunlap.

While visiting in a city not more than one hundred miles from Buffalo, I happened to call at the M. & M. Electric Light and Power Co.'s plant. On entering the door, I was accosted by a neatly-dressed man who very abruptly asked me my business. I explained to him that I followed the engineering business and was just on a visit to Mr. ——. "Well, step right in and I'll show you around, I am quite well acquainted with your relative." I followed him through the entire plant, which was a model of system and neatness. During the course of our conversation, this man told me he was not the engineer but the owner, and he brought particular stress to bear on the fact that he was the whole thing, etc. The conversation led to different types of engineers, and very shortly he began to upbraid his man by pulling a requisition out of his pocket and commencing to read it, and after each item he would cry about the expense.

The course of the conversation was carried on something like this. The first item on the list was for assorted sizes of valve discs of a certain make. "Why, I got him some of those only four months ago; surely he can't need any more again so soon!" "But," I said, "are you sure the same sizes are wanted this time, and are they the same kind? You know that there are many different kinds of valves that have removable discs." "Well, I suppose I'll have to get them," were the words in undertone from the *Prop*. "Then, look here," says he, "he wants some piston rod packing and just look there," pointing to an open drawer, "there is enough to last this plant five years." I looked at the packing carefully, then at the man, and I told him that it was no good. He wanted to know why.

After a careful explanation of the different qualities of the materials contained in packing and the effect heat had on them, he became convinced that he had better get some new brand. I asked him where he got the packing and he said at a clearance sale of a large engineers' supply house. "Why," he said, "I only had to pay 30 cents per pound for it and just think! the kind that the engineer wants is $1.25 a pound, but I suppose I'll have to get it!" (With a sigh.) I then looked at the piston rods and they were badly scored, caused by inferior packing and but *putting* ¾" *special packing* in a gland that should only have 11-16" at the most. This packing had to be pounded and then driven in, so what could be expected even if the packing was a fairly good article? It would probably score the rods just the same. But what could the engineer do but put it in, or quit? However, I persuaded the proprietor to get the good packing. A day or two later, the engineer told me that my visit had had a wonderful effect on the boss.

The next item on the list was some ¼" pump plunger packing for hot water. "Well, now, look here," says the Prop., pointing to a shelf in a cupboard, "there is some plunger packing I bought about three weeks ago, and it is nearly used up." "No wonder it is used up," said I, "that material is for cold water only; it is a wonder to me that the engineer will *put up* with such stuff, and, by the way, just measure that packing, it is scant 3-16" and the plunger only takes ¼"; get a special plunger packing for hot water and be sure to get the right size; even if it is $1.50 per pound, it will save you in the long run." He concluded to get it. Next was some repair work. The brasses on one crank pin needed lining with Babbitt metal; the piston rods and valve stems needed turning and the glands bushed, the cross-head pin on one engine had to come out to have high spots dressed down on it, some piping was wanted to pipe the discharge or feed line from injector through the heater, instead of direct from injector to boiler. The engineer wanted to have the injector connected up both ways, so he could feed with it through the heater or around it. Well, the Prop. could not see where anything could be gained by this move, and when I mentioned that some unforeseen accident might befall the feed pump, when he would be unable to use the injector, his argument was that they used the injector many times as it was. I asked him if there was any trouble with steaming with the injector and he said that the men complained of the hard firing at that time. I then told him that if he would put the water through the heater, it would save fuel. I asked him to start the injector and to put his hand on the feed pipe near the boiler. He did so and I then told him to put his hand on the feed-pipe, from the pump, there being two separate feed connections near the boiler. "Say," said he, "come over to my house this evening and we will go up and talk over these things with the engineer." We went together to the power house and in an hour convinced him that he had a good engineer, and he consented to get anything for the place that was needed. The result is that to-day he has a well-equipped plant and the engineer has full charge of it.

Starting up an Electric Plant Where a Balancing Set is Employed.

By William Kavanagh.

Engineers in charge of electrically-driven plants wnere no balancing set is employed usually encounter little difficulty in the cutting in or out of any particular circuit. It is very different, however, where a balancing set is employed.

In a plant where no balancing set is in operation or required, the cutting in or out of a circuit is accomplished by simply opening or closing the switch and noting the voltage. If the dynamo is compound wound and not carrying its maximum load at the moment the switch was closed, the voltage will increase a certain amount, so that, after closing the switch, it is correct practice to note its effect upon the voltmeter; any

increase in voltage can be lowered by means of the field rheostat.

In a simple electric plant, when closing down, the usual practice is to leave all the lighting switches closed and pull the main switch, and in starting up such a plant, it is only necessary to build up the voltage and throw in the main switch.

In an electric plant where a balancing set is used, the main switch can also be pulled when closing down, but *all* the lighting switches must afterward be opened. The power switches can remain closed providing all the auxiliary switches controlling the current to the motors are open. It is best, however, to pull *all* of the switches with the exception of the two-pole and single-pole switches controlling the balancing set. After all the switches are pulled with the above exceptions, the main switch can then be opened, then the switches controlling the balancing set and the engine shut down.

Where a balancing set is employed, no switches should be left closed after the plant is shut down for the following reasons: If the power circuits are wired for 220 or 250 volts, then the lighting circuits will be wired for 110 or 125 volts. Should a lighting switch be closed at the moment the main switch was thrown in, that circuit would be subjected to the voltage carried by the power lines and any lamps not "turned off" would be burnt out.

The power circuits should also be pulled for the following reasons: There may be one or more starting rheostats, the levers of which did not fall back to their non-starting position, in which case the closing of the main switch would subject the generator, motors and fuses to a severe test and in all probability trouble would be encountered.

Before starting up a plant wire as above, it is best to inspect the switchboard before closing the main switch, being sure that all the switches are open. Having done this, the voltage can now be built up to the proper point and the main switch closed. Now that the current is on the board, the balancing set can be started, after which all the other switches may be closed. In closing the power switches, it is best not to use both hands and close two switches together, as some motor rheostats may be encountered which did not open when the plant was closed down, but this difficulty may be on different lines, hence the difficulty will be met as each switch is closed.

For instance, suppose there are three 35 horse power motors controlled by one switch and six 10 horse power motors controlled by another switch, all connected to the same switchboard. Assume that the power switches were closed at the moment the main switch was connected to the bus-bars, then if one of the 35 horse power starting boxes along with two of the 10 horse power did not open when the plant was shut down, the amount of current demanded at that instant would equal or exceed the maximum current required when the motors were working at their full capacity and it is very likely that the fuses in the panel boxes would be blown. It is therefore best to open all switches before pulling the main switch or stopping the balancing set.

Another case very apt to occur is the breaking down of the balancing set. In this case, don't wait to find the trouble, but pull all the lighting switches as fast as possible. After this is done, try to locate the difficulty. Suppose the difficulty found and repaired; the balancing set may be started again and then the lighting switches closed. It is not necessary to pull the power switches when the balancing set breaks down.

A condition very likely to arise is the accidental pulling of the power switch. Suppose a power switch was accidentally pulled and almost instantly thrown in again, the difficulty encountered here would be that the closing of the switch may be at the wrong moment for the reason that some of the starting levers of the rheostats or controllers may be partially closed; in other words, the levers did not have time to reach their non-starting position. When such an accident occurs it is best to wait a few minutes, when the switch can be closed and the motors controlled from that switch again started.

Clearance.

Clearance in a steam cylinder is necessary (1) to provide for any slight inaccuracy in the setting of the cylinder in relation to the crank shaft; (2) to provide for inequalities on the surfaces of the piston and cylinder cover; (3) to provide for the slight errors which may occur in the lengths of the piston-rod, connecting-rod, and crank arms; and (4) to provide for the wear which takes place at the cross-head, crank-pin and crank-shaft bearings.

The amount of clearance varies with the size of the engine, being about one-quarter of an inch in small engines and seven-eighths of an inch in large engines. In horizontal engines, the clearance is generally the same in both ends of the cylinder, but in inverted cylinder engines, such as are now used in steamships and large power houses, the clearance at the lower end is usually about one and one-half times the clearance at the upper end.

The clearance volume is usually expressed as the percentage of the volume swept through by the piston in one stroke and it varies from 2 to 15 per cent. in different cases.

Thermite as a New Welding Material.

A new substance for welding rails and broken shafts has been used abroad. It is known as thermite and great things are promised for it. The thermite rail-welding process has already been used to unite 20,000 joints in a number of different European cities. The rail ends must be cleaned from rust and dust by a wire brush and then slightly warmed. A mould is then fitted around the ends and the thermite is heated in a crucible directly above the entrance to the mould, into which it flows as soon as the temperature rises to the melting point. In welding a heavy shaft the mould is built up around it and the heat applied to the crucible as before, a process which might save valuable time in many cases.

Pickled Steel.

While the method of pickling steel has for a long time been used in Europe, its introduction in this country is of more recent date. When the Williamsburg Bridge in New York City was erected, the steel channels were first boiled in a ten per cent. solution of caustic soda to take off the grease and then rinsed in boiling water. Afterward they were dipped in a ten per cent. boiling solution of sulphuric acid until all the oxide was removed. After being rinsed in boiling water again, they were dipped into a ten per cent. boiling solution of carbonate of soda to free them from any trace of acid. They were then rinsed with boiling water, dried over steam pipes and finally treated with a coating of enamel.

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Preparing Boilers for Inspection.

In our last issue we published a few rules for preparing boilers for inspection. Whether these rules are adopted or other methods used in cooling off and cleaning out the boiler, the thing to be kept in mind is the fact that everything should be arranged so that the boiler inspector can work under the most favorable conditions.

In far too many cases the boiler inspector is looked upon as a nuisance and everything is done to hinder his inspection, when the reverse should be true. Everything should be done so that a perfect inspection can be made because in making the inspection, the inspector, owing to his experience in hunting out defects, can often find things which when remedied will not only increase the safety of the boiler but the efficiency as well.

An engineer's reputation is often injured by not having the boilers clean or in good condition at inspection time. A travelling inspector was recently asked by the owner of a plant who was looking for a good engineer to take charge of his plant, what he thought about a certain engineer in a neighboring town who was recommended for the place. The inspector having recently had to crawl through a series of dirty boilers in the plant where the engineer had charge, could not, of course, be expected to praise the qualifications of that engineer and while such things are really very trivial matters, yet they may mean much or little to the man about whom they are spoken. "Yes, he is a fine engineer; his plant was in apple-pie condition," is something which no engineer need feel ashamed to have said about him.

Regardless of ulterior motives, however, it is a recognized fact that boilers should be inspected at regular intervals, and at those times the boiler should be in such a condition that not only is the engineer "respected" but the boiler as well.

Flue Gases and Boiler Setting.

The question often arises, when setting a tubular boiler, whether it is advisable to carry the flue gases over the top of the boiler after they have passed through the tubes or flues, or whether it is better to pass the flue gases out of the chimney when they have returned to the front of the boiler, enclosing the top of the shell with some good insulating material.

Each method has its advocates. Those who are in favor of allowing the flue gases to go over the top sheets claim that unless forced draft is used, the temperature of the flue gases will never be high enough to injure the top plates, as the temperature required to heat iron to a red heat is about 900 degrees and the exit temperature of the flue gases should never exceed half of that amount, while the excess temperature of the flue gases not only prevents any radiation from the top of the boiler but it tends to superheat the steam in the steam space.

This latter idea seems to have gained such a hold upon men familiar with boilers, that a few years ago a committee, which was appointed by a large mechanical society to investigate the best form of stationary boiler for the shop for obtaining superheated steam, recommended the return tubular boiler so arranged that the hot gases are permitted to return over the top of the boiler shell after leaving the flue instead of passing directly to the chimney. In their report, however, they say that there is some liability of the plates becoming bulged from the intense heat and also soot lodging on top of the boiler.

With all due respect to those gentlemen who maintain that flue gases should be allowed to come into contact with the top plates, which have steam on one side, either for the purpose of increasing the efficiency of the boiler or of superheating the steam, we think that the advantages to be gained are small compared with the disadvantages encountered.

The deterioration of boiler plates exposed to the fire or flue gases, without water on the other side, is rapid and the effect on seams is apt to be disastrous. The argument that the boiler is capable of absorbing more heat by allowing the steam surfaces to come into contact with the heated flue gases is quite plausible, but when it is considered that steam at 100 pounds pressure corresponds to a temperature of 327 degrees and that the flue gases may go out of the chimney at 350 to 400 degrees, the amount of heat absorbed is not very great even supposing

the top of the boiler plates to be free from soot.

Even those favoring the method of passing the flue gases over the top of the boiler admit that means must be provided for removing the soot which would accumulate on the top plates, so that if not kept clean constantly, their value as a heating surface is almost negative. In reference to superheating the steam by this means, it is a well-known fact that steam cannot be superheated when in the presence of the water from which it was generated but if it were possible, the fact that the flue gases must be comparatively low in temperature so as not to injure the plates almost eliminates this as a factor for consideration.

The disadvantages encountered when setting the boiler so as to allow the flue gases to strike the steam surfaces are numerous. Not only are the plates liable to overheat and deteriorate, but the effect on the seams must be considered. Here there is a mass of metal with conditions such that there is comparatively little transmission of heat and deterioration must follow. More draft is also required owing to the increased distance traversed by the smoke and gases so that an increased height of chimney is often necessary.

Considering the many disadvantages which have been mentioned, and the fact that it has not been proven that an increased efficiency has been attained when the flue gases are allowed to pass over the top of the boiler it seems to be the safest course never to allow the flue gases to strike any part of the shell which does not have water on the other side.

The Torque of a Motor.

For the benefit of several readers, who have had trouble in understanding just what the torque of a motor is, it might be well to point out a few of the principles involved.

Since the torque of a motor is its twisting moment, it is directly proportional to the number of turns on the armature, the current flowing through the coils, and the strength of the magnetic flux in the air gap. As the number of conductors on the armature is constant, the torque is therefore proportional to armature current and air gap flux.

The armature current flowing through the coils is the proportional to two quantities, the impressed electro-motive force and the back electro-motive force. The impressed electro-motive force is, of course, the voltage of the outside circuit, while the back electro-motive force is the voltage which is generated in the armature conductors as it revolves in its field and since the back electro-motive force is always generated in the reverse direction to the impressed electro-motive force, the resultant electro-motive force is the algebraic sum of the two. It is this resultant electro-motive force that sends current through the armature and which therefore produces the torque.

When a motor is running free without any load on it, the back electro-motive force is almost equal in value to the impressed electro-motive force and hence the torque is comparatively small. When, however, a load is thrown on the motor, it slows down sufficiently, assuming it to be a shunt motor, so that the back electro-motive force is reduced and current in the armature increases to overcome the increased work.

In starting a shunt motor, the current in the armature and hence the torque would be excessive, if resistance were not placed in the circuit in series with the armature, because the back electro-motive force being zero when the motor is at rest, the full value of the impressed electro-motive force is available for driving current through the armature. By adjusting the external resistance, the starting torque can be adjusted to meet any requirements. After the armature is in motion, the back electro-motive force starts to build up and cuts the current down until it reaches such a point that the current it allows to pass through armature is just sufficient to give the required torque at that speed and some resistance must be cut out in order to get an increase in speed.

After all the resistance in the armature circuit is cut out, any change in speed of the motor changes its torque. If the load be increased, the armature must run slower to allow more current to flow to increase the torque and when the load is decreased the armature revolves faster due to its lighter burden, so that the speed is proportional to the torque in such a relationship that current is allowed to flow to produce any torque demanded by the load.

If any of our subscribers in and around Port Arthur did not receive our paper during the siege of that city, we will be pleased to send them the numbers which they have missed, if they will kindly notify us.

Frozen water pipes are now being thawed by electricity to such an extent that some electric companies have on their staff men who make a specialty of doing this work. The average pipe can be thawed from 10 to 20 minutes without any damage to the fittings or surroundings.

When pumping water through pipes and valves, all water passages and areas through valves should be of sufficient size so that a velocity of 250 feet per minute is not exceeded.

The California Gas and Electric Corporation are about to install three 4000 kilowatt, 3-phase, 13,200 volt, 25 cycle revolving field alternating current generators to be driven by 5400 horse power gas engines, running at 88 revolutions per minute. These generators are the largest in capacity ever driven by gas engines and they will furnish power for operating all the street railways in San Francisco and vicinity.

PIPING STEAM HEATING PLANTS

Difficulties Encountered and Remedies Introduced

By W. H. Wakeman.

Inasmuch as the unbalanced pressure in a steam heating plant is small in nearly every case, regardless of the steam pressure carried as indicated by the gauge, and as the successful operation of the system depends upon this unbalanced pressure, a few suggestions along this line should prove valuable to engineers who are in charge of plants that are not always satisfactory. Steam fitters are sometimes blamed for piping that does not work well, when they do not deserve harsh criticism, because they seldom operate a plant after it is completed long enough to discover all defects, make experiments, and determine the most efficient remedy.

Of course, they may be told by engineers of troubles endured until remedies could be applied, and such information ought to help in the matter, but this not equal to personal experience, nor yet to seeing these matters well illustrated in a mechanical

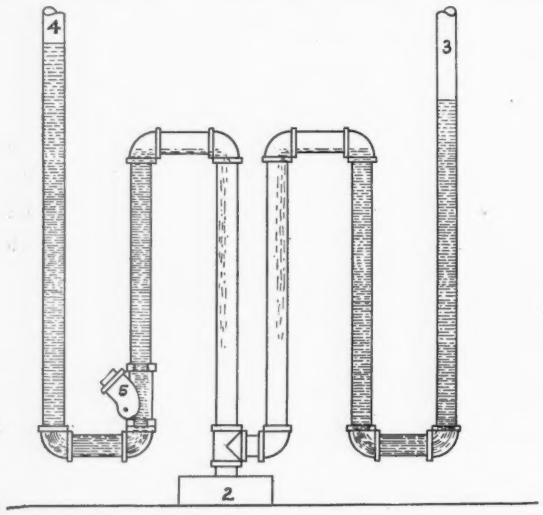


Fig. 1.

paper where the statements made are open to criticisms from thousands of competent readers. For illustration of this idea, I mention a case where a steam trap was connected to a large steam heating pipe. This trap discharged its hot water into the sewer, the discharge pipe falling continuously from start to finish, so that no water could stand in it at any point. A drip pipe from the exhaust pipe of a large pump discharged into the same outlet. Nobody anticipated trouble from this source, but an objectionable feature developed soon after the plant was started, for steam backed up into other sewer pipes in the building, creating offensive odors and endangering the lead joints in soil pipes, etc.

The remedy, which was very simple, is illustrated in Fig. 1, where 2 is the outlet to sewer, 3 the exhaust pipe drip, 4 the discharge pipe from trap containing the swing check valve 5 which opens upward. This arrangement forms a natural automatic trap holding water which prevents steam from going to the sewer. The water level in 3 is above the corresponding level in the other leg of trap in order to overcome friction, while it is higher still in 4 because there must be enough unbalanced pressure to open the check valve 5. These natural traps are about 3 feet high, therefore water stands above this

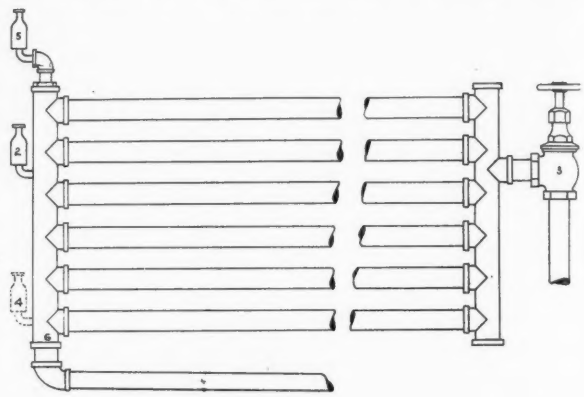


Fig. 2.

check valve, but this is balanced by water in the other leg of trap, consequently it needs to be but a few inches higher at 4 in order to open the swing check valve. This valve was located at this point to prevent water being forced back into the trap at a point above 4 not shown in the cut, as other pipes discharge below 2, which sometimes create pressure at this point. A globe check valve will not answer for this place.

Fig. 2 illustrates a pipe radiator which did not give satisfaction as water would stand in it at times, thus preventing it from heating the room properly. This is a very long radiator, which feature is not especially objectionable provided ample

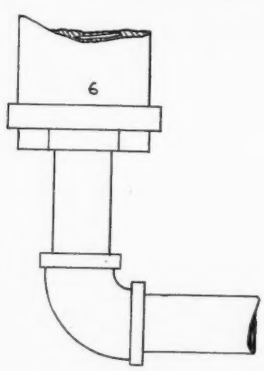


Fig. 3.

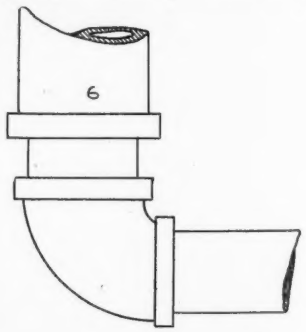


Fig. 4

chance is given it to expand when heated and to contract when cold, but it does give a good chance for air to collect and cause trouble. The drip pipe from this radiator was only ¾-inch with a pitch of about 3 inches in 20 feet, therefore water resulting from condensation did not flow away rapidly. There was no air valve on this drip, as it is well known that air

valves seldom do good service in such places, as they become choked with water.

As originally erected, the air valve shown at 2 was the only one supplied, and when steam was turned on at 3 it operated as follows: As the inlet pipe was not directly opposite one of the radiator pipes, steam was distributed nearly in equal quantities in the three upper pipes, but this caused air to be completely trapped in the lower pipes and especially in the drip pipe, which was of most importance. The reason for this will be readily understood, for as soon as steam strikes a properly-adjusted air valve it closes at once, and remains closed until allowed to cool. As air was trapped in the lower part only, an air valve shown in dotted lines at 4 was added, but was of no value whatever, as it would only discharge water on the floor unless screwed down so tightly that nothing could pass through it, therefore it was removed. Another was put on at 5 and it (in connection with 2) removes all air from the heating pipes.

Here I will call attention to the plan adopted for connecting the drip pipe into the lower part of the header. Fig. 3 is an enlarged view of this part which needs explanation. The header at 6 is tapped for 1½-inch fittings and a 1½ x ¾-inch bushing was screwed into it, followed by a ¾-inch nipple and an ell of the same size. It will be noted that the nipple is longer than is necessary, which is a mistake, because every inch that

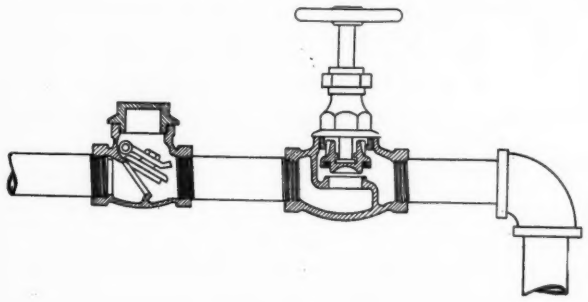


Fig. 5.

the ell is lowered reduces the possible pitch of the drip pipe an equal amount, and although this pipe was long, but little pitch could be given without going below the floor, and this could not be allowed here. A long drip pipe with little pitch is always a bad feature and should be avoided by carrying it into the room below if there is no other way to secure more pitch.

The above arrangement of pipe and fittings caused water from the long coil or radiator to fill the ¾-inch nipple and prevent air from reaching the air valve as it formed a complete plug at this point. Had the pipe been large enough to allow water to pass down, and air to return at the same time, before it was compressed enough to create pressure, less trouble would have resulted.

The plan shown in Fig. 4 was adopted and worked well. The bushing was removed and a short 1½-inch nipple substituted, followed by a reducing ell 1½ x 1¼ inches. The pipe was then increased to 1¼ inches, nearly its whole length until a point near the drip valve was reached, as a new valve was not necessary. This prevented water (which comes in large quantities at first) from closing the outlet, and permitted some air to work out of the drip pipe.

The arrangement of valves in this case needs special attention. It is illustrated in Fig. 5. The swing check valve is proper but a globe valve where the stem must be vertical, in a pipe that is nearly horizontal, is very much out of place, especially where the unbalanced pressure is so light, for it did not exceed what would be given by a head of 6 inches of water

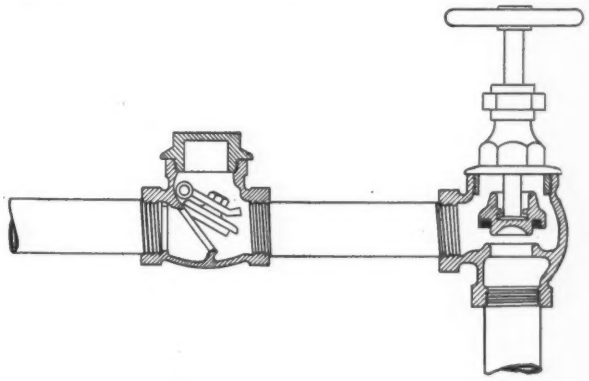


Fig. 6.

and was often less. In consequence of this fault the pipe would stand nearly full of water at best, and under common conditions it was completely filled.

The arrangement shown in Fig. 6 is very much better, and there was no good reason why it could not have been adopted, provided a valve was required here. The angle valve offers but very little more resistance than the ell shown in the previous illustration and the globe valve is eliminated.

Why is it necessary to have a valve at this point in addition to the check valve? Fig. 7 shows the way in which this was finally arranged and it works well. Why is it not suitable for other places? In place of the ell or the angle valve on the end of riser 2 a tee is placed, connected up "bull head" fashion, according to the steam fitters' vernacular. Into one end of this an air valve 3 is connected in order to let air out of the nearly horizontal drip pipe, also out of the riser 2, for in modern steam heating plants the steam pipes are connected with the returns in many places, therefore steam often comes up the risers before it gets there from the radiators or coils. This air valve 3 assists greatly in getting the room warm, for

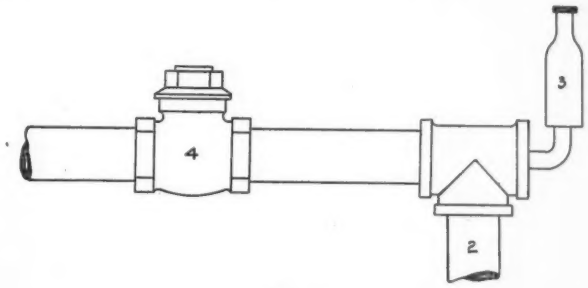


Fig. 7.

when steam is turned into the system in the morning, it must first drive out the air before heat will radiate. Entering by the valve 3, Fig. 2, it drives air in the heating pipes out through 2 and 5, but the drip pipe under the radiator is still partly filled with it, as already mentioned. After the air valve 3, Fig. 7, was added, it provided a way of escape for this air,

until it is closed by heat in the usual way. Water does not readily reach this valve because it will not come up through the riser 2 and that which comes through the check valve 4 falls into the riser 2, therefore it results in a good working air valve on a return pipe.

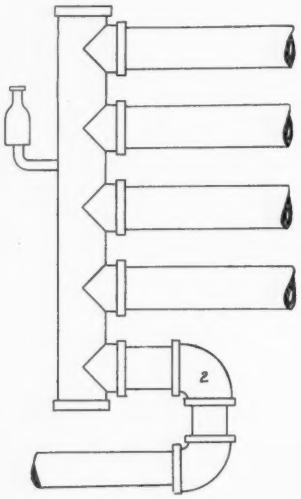


Fig. 8.

When it is desired to shut off steam, the inlet valve is closed and as condensation takes place in the radiator a partial vacuum is formed therein, for this radiator is supplied with vacuum air valves which do not allow air to come in after steam is condensed. As there is no drip valve on the return in Fig. 7, air or steam would rush in from the riser 2 if the check valve 4 did not prevent it. So long as it remains air-tight it answers every purpose and makes one less valve to handle and take care of.

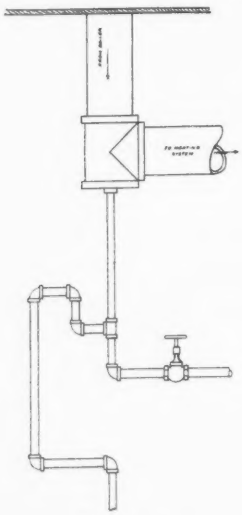


Fig. 9.

Fig. 8 shows the drip end of another pipe radiator which gives satisfaction in service. It is made of 1½-inch pipes with an outlet of the same size. The ell 2 is 1½ x 1¼ inches and the drip pipe is not further reduced, but is carried full size to a trap located in the basement under it. This pipe is fitted with a valve, but it is not used, as there is also a check valve on it which acts automatically and answers every purpose. As this is about 4 feet below the part shown there is chance for a sufficient head of water to open it as far as may be necessary to keep the radiator in good working order.

Fig. 9 illustrates one corner of a 7-inch heating main as it extends beneath the floor. The 1-inch drip pipe shown was formerly carried straight down into a large return pipe, thus affording a connection between the live steam main and the return, which was not trapped, therefore steam readily passed from one to the other. The natural trap shown causes water to stand between the two, therefore is more satisfactory. When steam is shut off from this system, three valves must be closed. In case either of these leak slightly, the resulting water formerly went to the receiver where it was not wanted, while the plant was shut down, but by opening the valve shown, this is prevented and the receiver is kept dry during the summer.

One point to be noted in this connection is that this is accomplished by the use of one valve only. It is impossible for a valve to be closed unintentionally that will prevent water from draining out of the main pipe, and no water can go to the return pipe while this valve is open.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Opening and Closing Valves. Never Once Used a Wrench.

EDITOR THE PRACTICAL ENGINEER:

I would like to say a few words about the above subject as I have had 7 years' experience around engines and I have never had occasion to use a wrench on a valve for these reasons: Suppose we take a Jenkins' valve which has celebrated seats that are removable. It does not take a very hard twist to set the valve steam tight. Now, suppose we have a 6-inch valve which leaks a little after we raise 80 pounds pressure.

The question is: "Would it be practical to place a wrench on that valve and try to 'twist' it tight?" I say *no*. Why? Because it might fracture the seat and ruin the whole valve or make it leak worse than before. I once saw an old disc replaced by a new one and the engineer got up 80 pounds steam and the valve leaked a little. What did he do but use his whole force on the valve and the result was he fractured the valve seat, causing it to leak so badly that he had to draw his steam down, causing a delay for half a day. This was caused by the use of a wrench.

I do not agree with E. N. Gine on page 20, of the December issue, where he says every engineer has had occasion to use wrenches on valves. I can tell him of a number of engineers with wide experience that never have used wrenches to close or

open valves. My way, when a valve leaks, is to regrind or replace the seat; if that does not help the difficulty, replace the leaky valve with a new one.

Shirley, Mass. H. N. B.

—o—

Opening and Closing Valves. Mr. Wakeman has not yet Received Satisfactory Evidence that he is Wrong.

EDITOR THE PRACTICAL ENGINEER:

As several of your correspondents do not seem to understand what my claims are on this subject, I will repeat them. First, not every valve on which a wrench is used is ruined by the process. Secondly, many of the leaky valves found in practice were not made so by the use of a wrench.

I would respectfully suggest that other writers who may take up the subject should bear the above in mind, and not convey the idea that I have made other claims which cannot be found in my letters. I have produced evidence enough to prove the above claims in any court of justice, and no evidence to the contrary has yet been produced, including the January issue.

Several writers have shown that some valves are ruined by the injudicious use of a wrench, but I have never disputed this fact. On the contrary, I have told about valves ruined in this way. When a correspondent tells about picking an old valve out of the scrap heap and having taken off the bonnet finds that the seat is ruined, his testimony is not worth the space it occupies, so far as the use of a wrench is concerned, for according to his own statement he has no positive knowledge on the subject, having never seen the valve used.

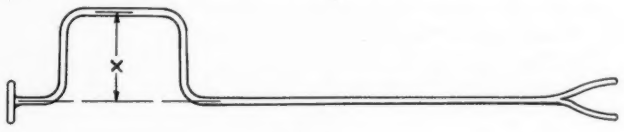


Fig. 1.

Since this discussion began I have had to reseat one valve with a valve reseating machine, and put new discs in three others, and while a wrench had never been put on either of these four valves, yet the disc in one of them was split into four pieces, which appears like very good evidence to show that all valves are not made leaky by wrenches. I have not previously mentioned these valves.

There is one point which has not been made clear by any correspondent, yet it is an important part of the subject, as follows: What is the comparative leverage brought to bear on the stem of a valve by using the wheel, and by putting on a wrench?

In the January issue a device for opening and closing valves is shown, which resembles a large brace such as carpenters use. Although I have never used one of these, they are known to be very convenient for use in places where valves are high above the floor, with wheels downward, as it saves many journeys up and down step-ladders. The correspondent who presents this device does not favor its use, but still does not give any good reason for rejecting it. He says that the plant in which he saw it contained many leaky valves, but I have shown that leaky valves are found on which a wrench was never used, hence the fact that those valves leaked does not prove anything.

In order to make my meaning plain, Fig. 1 is introduced. Whether the use of this can do any harm or not, depends on the distance between two points which I have marked X, as it is an unknown quantity. If it is 6 inches this is all the leverage that can be secured by its use. Fig. 2 shows a valve wheel 6 inches in diameter, giving a leverage of 3 inches on each side of the stem, or 6 inches in all. If the leverage secured by Fig. 1 is no greater than by Fig. 2, how can its use be more destructive? We have no means of knowing unless these dimensions are given. Fig. 3 represents a valve wheel 12 inches in diameter, giving a leverage of 6 inches on each side of the centre of valve stem, or 12 inches in all. Fig. 4 illustrates the same wheel with a 10-inch wrench on its rim. From the centre of valve stem to centre of handle is 12½ inches, giving practically the same leverage as the wheel when grasped with one hand on each side, without a wrench.

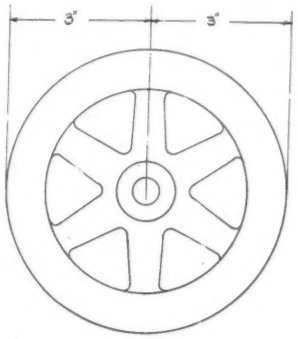


Fig. 2.

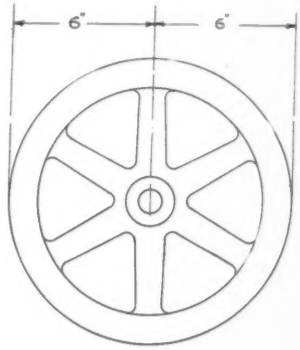


Fig. 3.

If one hand is put on the wheel and the other grasps the wrench, the leverage is increased, but many times the wrench alone is used as a lever. Ever since I put my hand on a valve wheel which was so hot that a large piece of skin clung to it, making a painful wound, I have much preferred the cool wrench, as shown in Fig. 4.

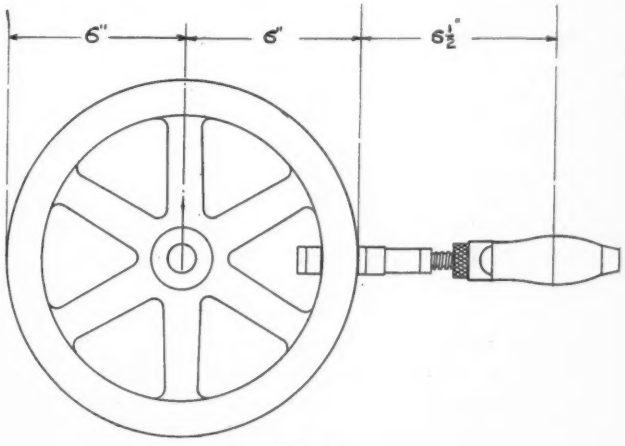


Fig. 4.

On page 22 of the January issue, "A. K. Valve" says: "Had this valve had the pressure on the top instead of on the under side at the very instant the disc became detached from the stem, the steam pressure would have forced it down on the seat, and the plant would have been out of business," etc.

This is probably true of the case he mentions, but it does not always work that way. The chief engineer of a plant containing engines large enough to require a 12-inch steam main, found that when he took an indicator diagram from one of them it showed that full pressure was realized at the beginning of the stroke, but it fell rapidly as the piston advanced. This engine was doing its regular work, giving no intimation of a defect anywhere, except when a diagram was taken. As soon as possible the stop valve (not the throttle valve) for this engine, was examined and the disc was found lying on the seat, having come off from the valve stem. In falling it had not settled down fairly on the seat, as one side of it rested on a part of the body, hence steam enough passed through to keep the engine in motion.

New Haven, Conn. W. H. WAKEMAN.

Opening and Closing Valves. Believes in the Use of the Monkey-Wrench Regardless of who is Against It.

EDITOR THE PRACTICAL ENGINEER:

I have been interested in the discussion of "Opening and Closing Valves" and I would like to say something in regard to the criticism of some of the writers against Mr. Wakeman. I believe I have forgotten a great deal when I read the letters signed A. T. and E. N. Gine.

I have been engineering both marine and stationary in all parts of the world and I am sorry I did not read some letters like A. T.'s years ago when learning my trade as an engine builder. Where James Watt first invented engines I was taught to use the monkey-wrench on large valves when they were first used, and I have adhered to the practice to this day. I have 3-inch Jenkins Y blow-off valves on my boilers, the discs of which were renewed in 1901 and they are good yet. The monkey-wrench is applied to these valves twice daily and I have never broken a valve stem or monkey-wrench yet; funny, isn't it? Probably the wrench the fireman uses is not heavy enough to twist it off, but it suits me. I keep two monkey-wrenches hung in the boiler room for boiler valves, one 8-inch wrench for the blow-off valves and a 14-inch wrench for the 10-inch stop valves.

I don't think the man is living who can shut a valve over 2 inches tight by hand with 80 or 90 pounds pressure under the disc. To prove it, take a 2-inch pipe in the boiler room, put a 2-inch valve near the boiler, 10 or 12 feet away put another 2-inch valve, now close valve furthest away from boiler, then close valve near boiler, go to valve you closed first, and see if you can't make a half turn tighter. This will show that it is impossible to close a valve above 1½ inches tight by hand, but, in the first place, if a wrench had been used with judgment it would have been tight. The valve that can stand 90 pounds pressure can stand a little monkey grease.

In behalf of Mr. Wakeman, his claims are right. Some of your writers have seen more careless handling of steam plants than I have, such as valve stems being twisted off or broken. In these cases I suppose common sense and a large wrench were off for a holiday; of course, these are probably exceptions of Mr. A. T.

I have seen valve yokes and bonnets blown off the body, but it was not the fault of the wrench, it was structural weakness. Some engine builders make a clamp wrench to fit on large valve wheels so they can be more easily manipulated. Five years ago I put pilot wheels on my engine valves and they seemed to enjoy the extra leverage, as I have never had any trouble since. They are 10-inch common cast-iron globe valves, with brass seats, and discs, nothing fancy about them. I am surprised at A. T. and his adherents in the stand they have taken, for surely they have not been around much. I have never seen a large valve in a steam plant handled without a wrench. Mr. A. T. says he feels he is fully qualified in the stand he has taken, and I fully agree with him. He certainly has a model plant. He don't use a wrench on anything, nothing but plenty of elbow grease, but a wrench is easier, when backed with a level head and good judgment.

Mr. A. T. says he will condemn the use of the monkey-wrench, regardless of who advocates it and believes it to be wrong. Now I believe in the use of the monkey-wrench, regardless of whoever is against it, as I have used it all my life with never a defect from its use. I know Mr. A. T. asks why valves are allowed to get into this condition so as to have to use extra leverage. That is something new to me, for if I put on a new 10-inch valve to-day it is trained to the monkey-wrench from the moment it is in place. This has been my custom for 25 years. I myself have seen ignorance and an engineer working together many a time. On one occasion the engineer was tightening up a ⅝-inch nut and ignorance twisted it off with a 24-inch monkey-wrench.

E. N. Gine remarks about packing valve stems properly. Well, that is important, but indeed as I have forgotten to use graphite and cylinder oil it must be a new fad among beginners. I think I will have some used next time if I don't forget and the wedge packing also.

Opening and closing of valves is not a mathematical problem, but a case of common sense and a nice handy wrench.

Phila., Pa. A BROKEN VALVE STEM.

Opening and Closing Valves. One of the Three Great Topics Before the American Public.

EDITOR THE PRACTICAL ENGINEER:

As an appreciative reader of your paper, may I be permitted to say a few words to your readers?

At the time of writing, there appear to be three subjects of vital importance before the American public, viz.: The war in the Orient, the craze for physical culture, and the opening and closing of valves, the latter not being the least important, if the interest shown by practical engineers is any criterion.

Leaving the first two subjects to abler minds or to die a natural death, let us concentrate our energies on the solution of the great problem: Shall valves be closed à la Wakeman or without a wrench? That is the question.

Having been a student of this Journal for a long time, I can dimly remember the article written by Mr. A. T. which provoked this discussion. I thought it a very sensible treatise on the subjects it dealt with, but Mr. Wakeman evidently thinks that A. T. is writing through his hAT.

Now, I have been in the engineering business a short time and have seen and handled a few valves, so should be able to speak advisedly. By the way, in our plant *we* have a 7-inch valve, so the fact that A. T. and Mr. Wakeman are blessed with 7-inch valves is no serious matter for congratulation. But, as I remarked, my experience should count for something and I think something is to be said for both sides, and quickly

too, before the foundations of the Union are shaken by the violence of the discussion.

By all means, use a wrench on a valve if necessary. I make this statement after due consideration but not without qualification. The size of the valve and wrench is a potent factor in the case, so to avoid misunderstanding, I will cite an instance. On a ⅜-inch valve, such as is commonly used on water gauge connections, never under any circumstances use anything larger than a two foot Stilson. If the size of the wrench be exceeded, the valve disc will undoubtedly be injured.

If this is not satisfactory to all parties, I suggest that arbitration be resorted to and that Rodney Gumkirk (bless his heart) be appointed president of the arbitration committee.

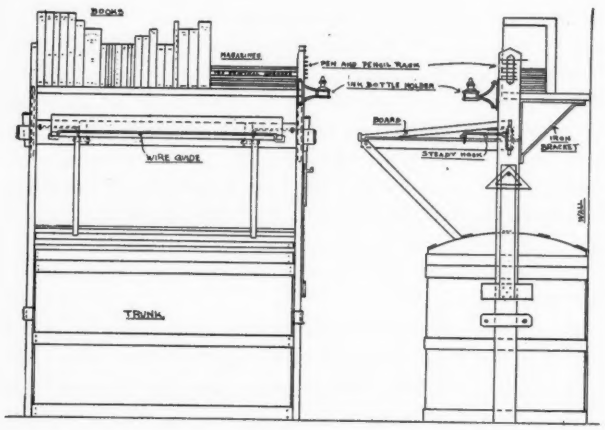
Edmonton, Canada. F. H. S.

A Handy Portable Drawing Table.

EDITOR THE PRACTICAL ENGINEER:

Enclosed please find sketch of a portable drawing table and book stand, designed and made by myself. As I have found it very useful and handy, no doubt many another travelling engineer or mechanic may find it of use to him.

As shown in the accompanying sketch, it consists of two uprights of such a width that they will fit tight into the handles of the trunk in connection with which it is used. The height would be determined by the user depending on whether he wishes to stand or sit to work. Between these uprights there is a cross rail about one inch thick with a long tenon on each



Portable Drawing Board and Book Stand.

end, fitting into a mortise in the uprights and held by a wooden wedge key. The drawing board is supported by two pieces of wood, the upper edges of which are cut to any desired angle and at the back upper edge has set flush a sheet metal strap bent over to hook over the cross rail. These are held sideways by a hook screwed to the cross rail and fitting into an eye screwed into the wood brackets.

At the other end, as shown, is a steady rest, which resting on the trunk helps to steady it the other way. I also shaped a wire threaded at each end and put through holes in the cross rail and held by a nut and washer on each side so that it would hold the board sideways and also prevent it from sliding off the brackets. This wire can be bent a little higher in front to keep articles from sliding off the board. At the back of the uprights iron brackets are screwed which support the shelf for books, and other shelves can be put on if desired. I also made of wire metal a swinging ink bottle holder. Also attached to the uprights there is a pen and pencil holder and a hook on which may be hung T-squares, triangles, etc.

The whole arrangement is easily and cheaply made and easily and quickly taken apart, folded for moving and put together again. While it might not look so, it is very firm and rigid.

Waterville, Conn. J. H. A.

Rodney's Troubles.
Or Do We Need a License Law in Michigan?

(Sixteenth Letter.)

Mr. editur, deer sur, it iz a hard thing to do tu rite tu u tu day but i must anser ure last letter wher u told me about the cut off injine. the reson it iz hard fur me tu rite iz be kaws my fut hurts me so mutch. ile tell u how it wuz. i wuz allus unezy about that cut off a ketchin me sum time or uther and 1 day last weak az i wuz gitten reddy to du sum thrashen up the rode a peece, i throde in the leevur what makes the masheen go ahed. well i haddent giv her enuf steam to karry her over the middel so in mi hurry to git her started i jist jumpd on to the big pully wheal, and in a jiffy she was a goin. i tell u i had to muve kwick but i wuz not fast enuf and the big hind wheal on the rite side run over all the tose of my left fut. i tell u mr editur i thot thet mi injine wuz a reel cut off injine until the dockter sed that he kud sav the fut as it wuz onle badly bruzed. i kin git around now but i hav tu uze a kain.

yisterday a man kum up tu whear i wuz doin some wurk fur skwire erhart and the man wanted tu sell me a buk az he sed it told awl about how tu sit the valvs on a enjine, how to repare brakdouns, awl about the kaws and prevenshun of fomen and primen, how to treet a biler fur skale and a lôt uv uther things. i told the fellar that i dident need enny sutch a buk fur no sutch things evvur hapend tu mi injine or biler, and i nevvur had tu tutch the valvs on mi injine but onst and that wuz 1 time this summer when a essentrik broak and i got a mesheenist frum the villidge to maik a nu 1 and put a bolt in the biler to hold the injine steddy. i dont kare to no enny thing about fixen the injine when its broak. i think it iz best tu git a man frum the shop whut iz supposd tu no all them things and he kin fix them mutch ezyier than i kin. and if ime willen tu pay him whats the difernse. az fur primen or fomen mi injine nevvur dun enny thing lik that and i dont need the buk fur enny thing ov that kind. now i dont think a buk iz mutch gud, do u mr editur.

theres 1 thing i wood lik to ask u befoar i finish mi lettur and it iz about mi biler. when i wuz washen out mi biler the uther day i tuk out a lot ov mud and dirt and henry wuz helpen me, so when we got dun and reddy tu put the wattur in agen henry told me to put in some taters and sum mennure so i did. i put in a littul over a bushel of taters and about the saim of mennure. the next day we done sum thrashen at gordens place and i hed a lot of trubble with the wattur in the biler, whi 1 minnit the glas ud be ful and the next minnit it ud be emty, and the injine wood klick and pound and thump and the steem and wattur would kum out of the stak and evvery buddy was kuvered with black sut and i kant think whut wuz the mattur with the blamd thing unles twas mi putten them few taters and that mennure in the biler.

Pleeze rite and tel me if i hav dun enny harm tu mi biler and whut maiks the wattur akt so funney in the biler

ures trooly

rodney gumkirk

orkners korners mishegan

munrow kounty

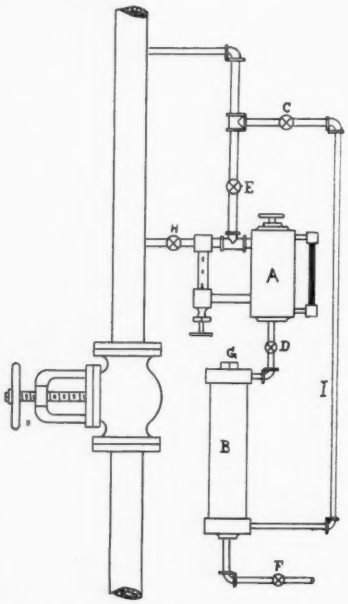
care mi father

—o—

Value of the Indicator. Arrangement of Lubricator.

EDITOR THE PRACTICAL ENGINEER:

I was quite interested in W. F. Burdick's article in the December issue on "Where the Indicator was a Good Investment," as I know of a similar case. An engineer was hired to run a small plant in a factory where they rent power. After a few days, when he had got his bearings, he put an indicator on the engine and found it was doing all the work on one end, which he remedied very easily. The proprietor happened to come in



Arrangement of Lubricator which requires filling twice a month.

at the time and asked him what he was doing. After being told, he wanted to know if he could get the power different tenants were using and as each floor had a clutch, this was easily done. On Sunday, the horse power of the engine and shafting was ascertained so that the exact power which each tenant was using was obtained. The result of it all was that the tenants had the rent raised and they never said a word while that engineer received his share without asking for it, and the firm now has an indicator and planimeter. So a little book learning in that case not only put dollars in the firm's pocket but in the engineer's as well.

I think I have a better home-made lubricator than J. G. S., of Brooklyn, N. Y., which he describes in the December issue of which I send you a sketch. My arrangement is made from old pipe and fittings and while he fills his three times a week, I only fill mine twice a month and if I had a 4-inch pipe instead of a 3-inch pipe I could have made one that would not have to be refilled as often as that. It is nothing more than a tank to hold the oil which is connected to the lubricator. A is the lubricator, B, the oil tank, C, D, E, F are valves. By closing C and D and opening valve F, the tank is drained and the tank is filled by removing plug G. After filling the tank, I fill the lubricator the usual way by opening valves C, D and H and keeping the valve E closed. The lubricator works in the usual way, the condensation going down pipe I forces the oil up and into the bottom of the lubricator. I have my tank standing up by a post in the engine room but it can be put anywhere so long as it is below the lubricator.

New Haven, Conn. G. S. G.

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Stationary versus Marine Firemen.

EDITOR THE PRACTICAL ENGINEER:

While reading over the November issue of "The Practical Engineer," I find some few lines where the marine fireman comes in for his share of the controversies and some one who imagines that the only fireman is the stationary fireman. Now, I have had experience in both marine and stationary service and as a man, I believe in giving honor where honor is due. It is a wrong impression for any one on shore to have that the man in the ship's hold is a block-head because he handles a No. 4 scoop, and that that is as far as it goes.

During the time I put in on some of the soft water vessels, I found some finely educated men in the stoke-hole and found them very willing to assist in time of trouble and distress and they were of particular habits in their routine of work. They by far excel the stationary fireman. One very seldom finds the marine fireman with a swelled head, but the same thing cannot be said for the stationary fireman, and so far as a stationary fireman doing good service on a ship is concerned, that is a mistake. I have had the stationary man and when he came to the scratch in the stoke-hole with the thermometer standing at 120° to 130° Fahrenheit, he wilted down and the engine room force had to stand at the doors of the furnace, and when one comes to think it over, the heat in the stoke-hole of an ocean tug or deep-sea vessel is far different from the heat of a stationary plant where the doors can be thrown open and the fresh air let in.

Compare the duties of the stationary and the marine fireman. When a vessel leaves port from the dock in a still and quiet harbor, she glides down gently into a rolling sea pitching and tossing from side to side, head down and steam up; a splash, a dash, a dull thud as the breakers strike the bluff of the port or starboard quarter, which send a quiver through the whole vessel. Does it not appear that the marine fireman is doing something fanning his fire with a No. 4 scoop in a rolling sea? The only thing on a vessel that remains perpendicular or in an upright position is the binnacle or compass.

Of course, I realize the fact that some one will say: "Who is this writer?" Well, anyway, he began 24 years ago in the tug-boat stoke-hole and to-day holds papers as "Chief of Condensing Steamers."

Battle Creek, Mich. M. J.

—o—

The usual amount of moisture in steam generated by a good boiler does not generally exceed 2.5 per cent. unless the boiler is forced or the water level is carried too high.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Setting Boilers in a Battery.

EDITOR THE PRACTICAL ENGINEER:

Will you please show in "The Practical Engineer" how to set two or more boilers in a battery? How thick should the wall be between the boilers and how thick on the outside? The boilers are 60 inches by 14 feet.

Menomonie, Wis. M. D. M.

An article on "Setting of Tubular Boilers," which was written to answer this and many similar questions, will be found in another column of this issue.—[Ed.]

Pumping Engine Efficiency. Work Done in Pulling a Load up a Grade.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly answer the following in your next issue?

(a) If a pumping engine performs 25,000,000 foot pounds of work for every 100 pounds of coal burned and the coal has a heating value of 12,000 British thermal units for each pound, what is the per cent. of heat used by the engine?

(b) If 3400 pounds of coal are used per hour, what is the horse power of the engine?

(c) How many gallons of water could the engine raise to a height of 125 feet in one hour?

(d) If a load is pulled up a grade one mile in length and the rise is 100 feet, what will be the horse power required if the load of 5000 pounds is pulled up in 5 minutes? Kindly give a general rule for same.

Bethel, Conn. W. F. S.

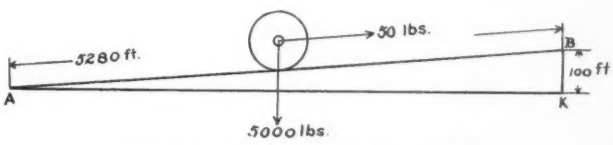
(a) As one heat unit is equivalent to 778 foot pounds of energy, 100 pounds of coal containing 12,000 heat units for each pound is equivalent to $100 \times 12{,}000 \times 778 = 933{,}600{,}000$ foot pounds. The per cent. of heat used by the engine is obtained by dividing 25,000,000 by 933,600,000, the result of which is 2.68 per cent. used by the engine.

(b) As 3400 pounds of coal are used by the engine and the efficiency from above is 2.68 per cent., then only $3400 \times .0268 = 91.12$ pounds are used for useful work. Then, since each pound contains 12,000 heat units, it makes $91.12 \times 12{,}000 = 1{,}093{,}440$ heat units available per hour. One horse power is equivalent to 2545 heat units per hour, so that the horse power of the engine should be, under the same conditions, $1{,}093{,}440 \div 2545 = 429$ horse power when using 3400 pounds of coal per hour.

(c) Since 429 horse power is exerted by the engine, according to above calculations, this is equivalent to $429 \times 33{,}000 \times 60 = 849{,}420{,}000$ foot pounds per hour. A gallon of water weighs 8.335 pounds and as each gallon must be raised a height of 125 feet, it will require $8.335 \times 125 = 1041.9$ foot pounds for each gallon. Therefore, by dividing 849,420,000 by 1041.9 it gives 815,260 gallons as the amount of water raised by the engine in one hour.

(d) In pulling a body up an incline, there are two factors which come into consideration: the work done against traction and the work done against gravity. To make it plainer, suppose in the accompanying sketch AB represents one mile or 5280 feet and BK represents the rise of 100 feet. The work done against gravity per minute is equal to the number of pounds in the load multiplied by the height through which that load is moved in one minute.

The work against friction is the resistance of the load multiplied by the velocity the load is pulled in feet per minute. The resistance is only some small portion of the load. Just what proportion depends upon many variables, such as the kind of wheels on the conveyance, the condition of the road on which it runs, etc., etc. In practice, air resistance is also a factor.



Work done in pulling a Load up a Grade.

If the load of 5000 pounds is pulled along a railroad track, the resistance would probably be near 20 pounds to the ton or 50 pounds for the load of 5000 pounds.

As 5280 feet are traversed, according to the problem, in 5 minutes, the velocity of the load would be 1056 feet per minute and the dead load would be lifted 1-5 of 100 feet or 20 feet each minute.

The problem is then as follows:

Total work done per minute = work done against friction per minute + work done against gravity per minute.

In which,

Work done against friction $= 50 \times 1056 = 52{,}800$ foot pounds per minute, and

Work done against gravity $= 5000 \times 20 = 100{,}000$ foot pounds per minute.

Total work done $= 52{,}800 + 100{,}000 = 152{,}800$ foot pounds per minute.

As one horse power is equivalent to 33,000 foot pounds, the horse power required to pull 5000 pounds up a grade one mile in length if the rise is 100 feet in 5 minutes will be $152{,}800 \div 33{,}000 = 4.6$ horse power.—[Ed.]

Why the Pump Races.

EDITOR THE PRACTICAL ENGINEER:

As I am a subscriber, I ask for a point of information. I have a 4½" x 2¾" x 4" Knowles duplex pump attached to a receiver situated below the boiler room level. It is used to take care of all the drips. There is also a water connection to receiver and also one from it for feeding boilers. The receiver

has an automatic float valve as usual in equipments of this kind.

Now, what I want to know is this: Sometimes the receiver will be full of water and the valve to the pump wide open, but the pump will race like fury, but she won't take water. I shut off steam to pump and in half an hour turn it on again, and she starts off as nice as you please. Now, why don't the pump take water, as the receiver is higher than the pump? The water in the receiver is hot and the pump is located in a very hot place.

Please let me know the cause and remedy for same. I would also like to hear from some of your readers on this through the columns of "The Practical Engineer."

Danbury, Conn. J. M.

The trouble experienced in this case is evidently caused by trying to pump hot water with the receiver located too near the pump. When pumping hot water it is necessary to have the receiver located at a considerable distance above the pump in order to get enough head on the suction to keep the vapors which arise from hot water under pressure at the pump so they may not expand and fill the clearance spaces on the return stroke of the piston or plunger. If the water is very hot, the receiver should be 8 to 10 or possibly 12 feet above the pump. The vapors liberated by hot water must be kept under pressure in order to have the pump work properly and not kick or race.

The reason that the pump works when it is first started off is because the pressure due to the static head will be sufficient to condense the vapor and perhaps also the temperature is somewhat lowered as the pump is allowed to stand for one-half an hour. When the plunger begins to move, this pressure is removed, the hot water will give off vapor and the suction will be broken.

If it is not possible to raise the receiver or lower the pump so as to get the sufficient head required, perhaps priming the receiver with a small jet of water will keep down the temperature so that it can be pumped under the present conditions. —[Ed.]

Size of Feed-Water Heater.

EDITOR THE PRACTICAL ENGINEER:

I would like to know how the size of hot-water heaters is figured? You often hear the expression, 200 horse power heater. What does it mean?

Danbury, Ct. J. M.

For commercial purposes, a feed-water heater is given a horse power rating, so that a 200 horse power heater is supposed to keep a 200 horse power boiler supplied with hot water at a temperature approximating 208 degrees Fahrenheit. Unless, however, the term horse power, as applied to a feed-water heater, is thoroughly understood, buying heaters by the horse power will often result in purchasing those that are either too small or too large. When determining the size of a heater required in any given case, the number of square feet of surface required in the heater for each horse power depends upon the maximum weight of water to be heated each hour, the temperature of water entering the heater, the temperature of the steam and the temperature to which the water is to be heated.

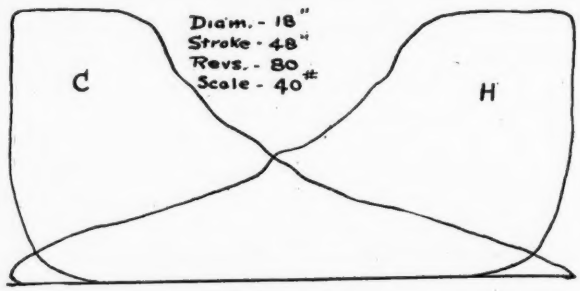
If it is assumed that a boiler horse power is the equivalent evaporation of 30 pounds of water per hour, then a 100 horse power heater should maintain a constant temperature of not less than 208 degrees with water flowing through it at the rate of 3000 pounds per hour. To do this, feed-water heaters should have nearly a square foot of heating surface per horse power. As they are usually rated, however, a commercial feed-water horse power will allow about one-third of a square foot of heating surface per horse power.—[Ed.]

Indicator Cards. Priming Boilers.

EDITOR THE PRACTICAL ENGINEER:

I have been taking your paper for some time and I think a great deal of it. I would like to ask you a few questions:

(1). Can I make any improvements on the enclosed indicator cards, which I took from one of our engines?



Can these Indicator Cards be Improved?

(2). One of our boilers is very limited in steam space and when the engine is running, the boiler seems to apparently jump or jerk up and down at each stroke of the engine and is predisposed to carry water over with the steam. The connecting pipes are plenty large. The boiler does not jump so badly when the engine is worked light and we carry the water in that boiler as low as we can. The boilers steam very freely and we do not have to rush the fires any.

Now, do you think the limited steam space would cause the boiler to act thus? I think the boiler would do better with top row of tubes taken out so as to give more steam space.

Cynthiana, Ky. J. S. J.

(1). Very little improvement can be made on the indicator cards as shown.

(2). In most horizontal tubular boilers, the steam room is nearly constant for a given diameter of boiler. The upper line of the top row of tubes is commonly two-thirds of the diameter of the boiler from the bottom; over this is from 2 to 4 inches of water depending on the size of the boiler; all above this is steam room.

If the boiler in question has not got as much steam room as this, then the taking out of the top row of tubes would be beneficial but if it has as much steam space as is usually allowed, then either the boiler is forced very much or the boiler setting is weak.

A boiler inspector would recommend at once that the boiler setting be examined and strengthened so that it will not permit the boiler to jump, as it is very hard on the piping and a boiler ofttimes explodes, due to the breaking of the main pipe near the boiler.

If the boiler setting is all right and the boiler still throbs or jerks, then the addition of one or more receivers in the steam line is necessary, one at least at the engine. This is of great advantage on any steam line, as the boiler makes steam constantly while the engine uses it intermittently, the effect of

the receiver being to decrease the velocity of steam in the steam pipe during those moments when the steam valve is wide open, which prevents the excessive priming of the boiler at those times, as it stores up the steam when the steam ports of the engine are shut.—[Ed.]

Engine Constant.

EDITOR THE PRACTICAL ENGINEER:

Will you please explain what an engine constant is?

New York, N. Y. W. G.

An engine constant consists of those quantities in the horse power formula which do not vary. In the horse power formula, H. P. = PLAN ÷ 33,000 in which P = mean effective pressure in pounds per square inch, L = length of stroke in feet, A = area of piston in square inches and N = number of strokes per minute and it is evident that when taking indicator cards neither L nor A change, nor the quotient 33,000, hence the two variable factors are P and N. The mean effective pressure is found by taking the area of an indicator card, dividing it by its length, and multiplying the quotient by the scale of the indicator spring, so that if a = area of card, l = length of card and s = scale of spring, then $P = a \times s \div l$, in which a is the varying factor.

If K represents the quantities in the horse power formula which are constant, then H. P. = KaN in which a is the area of the card and N is the speed of the engine. Very often P is worked out by a different method than outlined above, so that K would then be allowed to equal LA ÷ 33,000 and the horse power formula would become H. P. = K P N.—[Ed.]

More About Reversal of Polarity of Generator.

EDITOR THE PRACTICAL ENGINEER:

Will you please explain more fully your answer to J. K. in regards to his dynamo on the three-wire system that showed a reversal of polarity on the line?

I fail to see how a short circuit on the line can change the polarity of a dynamo and your answer is not quite clear.

Ironwood, Mich. C. B. S.

There is only one thing that will cause a shunt dynamo to change its polarity without changing its connections or direction of rotation, and that is reversal of the current in the fields. When a dynamo is shut down after having been in operation, there is always some residual magnetism left in the field to help build up the current the next time it is started, unless some outside influence affects it, such as vibration or jar, proximity of another dynamo, sometimes the earth's magnetism or an accidental reversed current through the field.

A vibration or jar will merely destroy the residual magnetism of the fields; the earth's magnetism is too weak to be considered as having any effect on the powerful field magnets and dynamos are seldom placed so close as to affect one another, so that the only cause why the polarity of the dynamo is changed would be the reversal of the current in the fields. It is usual to expect that when a dynamo's field dies down, the residual magnetism will remain the same as that caused by the current which last passes through it, but should this current for any reason become reversed before the machine is started up, the chances are that the polarity of the brushes will be reversed.

It is for these reasons that we said, in our November number, in answer to J. K., that it was probable that when the short circuit occurred, current flowed back on the mains of No. 1 machine, thus reversing the direction of the current in the fields. The short circuit itself would not necessarily mean that the current would be reversed, but when the short circuit with some other wire happened, it gave the opportunity of allowing current to be reversed by some other outside impressed electro-motive, probably from No. 2 machine.

A short circuit of the mains of a single dynamo would not reverse the polarity, but it must be remembered that there are two dynamos running together in this case.—[Ed.]

Book Review.

Suction Gas, by Oswald H. Haenssgen. Size 5 x 7¼. 85 pages and 4 illustrations. The Gas Engine Publishing Co., Cincinnati, Ohio. Price, $1.00.

The contents of this book contain a description of suction gas apparatus, the methods of construction of the different parts necessary and the care and handling of such a plant.

The art of producing gas from coal for use in gas engines has advanced to a finer degree of perfection in Europe than in this country owing to scarcity of fuel, which makes economy necessary, and for this reason European plants are looked upon as models in their line. This subject of suction gas has created much interest in this country and as very little has been written on this subject, the book has been published to fill the demand.

The generator, vaporizer, cooler, condenser, purifier, regulator, motor and piping of a suction gas plant are each described in their turn together with the best methods of construction. A valuable part of the book is the description of how to start the generator, how to start the motor, how to charge the generator, how to stop the system, how to clean the grates, how to care for the scrubber and how to clean the pipes.

The Ruggles Improved Flue Cleaner.

The requirements of a good flue cleaner are that it must adjust itself to variations in the diameter of the tubes to be cleaned, must thoroughly clean all spots in the tube, and must not catch upon withdrawal.

Ruggles Improved Flue Cleaner.

An arrangement which does this is the Ruggles Improved Flue Cleaner, manufactured by A. W. Gunther & Co., 407 Jefferson Street, Milwaukee, Wis. The accompanying illustration shows clearly the construction of the device.

It consists of a number of knives composed of a good quality of steel which has the property of not having its temper drawn except at a very high temperature; consequently, the cleaner is not injured by coming into contact with the hot flues. The knives are of such a shape that by merely pushing the cleaner in and out of the flue, it has the same effect as if it were twisted or revolved. After passing through the flue, the cleaner cannot

catch on the return stroke as the blades are made with the ends curving inward so that they will centre themselves in the tubes.

Since the knives are made of steel, they spring in or out as the tube becomes smaller or larger, each knife cleaning its own strip through the tubes, regardless of the others. This is very desirable, as few flues are of the same calibre throughout their entire length. The knives, therefore, will reach and clean all spots and over-ride without any extra adjustment, any uneven surface, whether convex, concave, flat, welded or thimbled.

When using the tool, it is only necessary to adjust the cup shown at the inner end of the illustration and push the flue cleaner through tube and draw back. They are made for tubes ranging in size from 2 inches to 5 inches in diameter.

Hughes Smoke and Spark Preventer for Stationary Boilers.

It is a well-known fact that the place where smoke should be prevented from forming is in the fire-box of the boiler. This can only be done by combining the carbon and hydrogen elements in the coal to the ultimate products of combustion. If these elements are not completely consumed in the fire-box or before they strike the comparatively cool walls of the boiler, then the result is smoke. Give to the coal, after it is fired, sufficient oxygen for complete combustion, then the formation of smoke is impossible.

One of the most simple devices which has yet been utilized for the prevention of smoke and which fulfils the above conditions is the Hughes Smoke and Spark Preventer, sectional views of which are shown in Figs. 1 and 2.

The invention consists of two brick arches, one above the other, forming a hollow arch extending from side to side of the furnace, with a gradually enlarging opening from the bottom upward. This hollow arch takes the place of the bridge wall

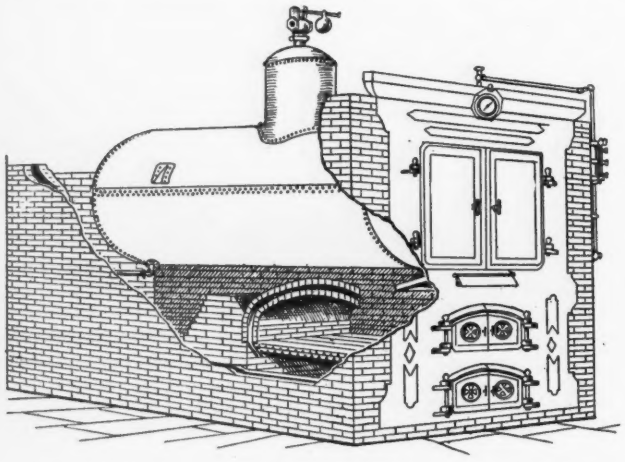


Fig. 1.—Hughes Smoke Preventer as applied to a Horizontal Boiler.

and extends the width of the fire-box. The air from the ash-pit passes up through the port at the bottom and becoming heated by the flue gases, is allowed to expand in the enlarged opening between the brick arches.

A small current of air is allowed to enter through the boiler front or fire-box door by means of tubes which are inclined at such an angle that the entering cold air does not strike the boiler surfaces. The small current of air meets the air discharged through the arch and acts as a baffle which forms an eddy and causes the gases and fine particles of fuel to be thoroughly consumed.

The result of burning the fuel perfectly is an increased economy of the boiler, and it saves labor, not only in the amount of fuel which must be fired, but the flues are thus kept practically free from soot. Having no moving parts, and using no steam or power, it can readily be installed in all forms of boilers and boiler settings.

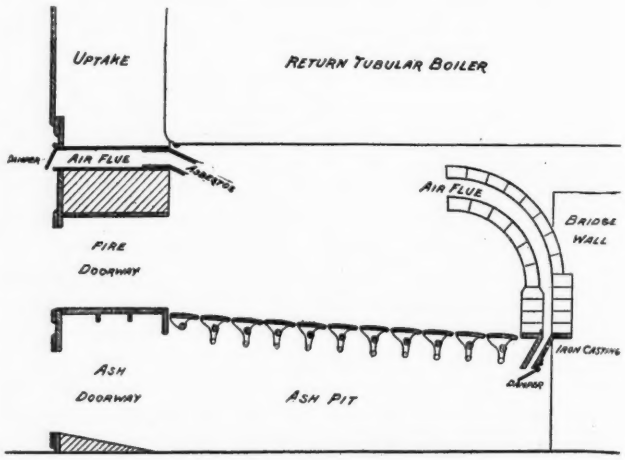


Fig. 2.—Sectional View through Fire-box showing arrangement of Air Flues.

It has been in successful operation for a number of years, during which time tests have shown it to be economical and efficient and where smoke ordinances are in force, it comes well within the limits of those ordinances by its effectual prevention of the black gas which is usually seen issuing from stacks where soft coal is used.

Its first cost is low, and the cost of maintenance is practically nothing except the small repairs to the brick work that may be necessary from time to time. There is no moving mechanism and there are no steam jets, therefore the prevention of smoke is a direct saving of fuel.

As shown in Fig. 2, the air flues are equipped with dampers which may or may not be used, depending on the kind of coal used and the degree to which the boiler is forced. With ordinary bituminous coals, it is usually better when the green coal has been heated and the smoke all consumed, to close the dampers between firing, but with poor coal it is often advisable to always keep them open. Tests have shown that it makes practically no difference in the economy and they are put on according to the wishes of the engineer in charge.

A Hughes furnace was recently installed at the Geo. Keller Brewing Co., Thirty-third Street below Master, Philadelphia, where it can be seen at any time. Owing to small space in the fire-box and the use of bituminous coal, this plant has been continually annoyed with smoke, but since the installation of the Hughes furnace, the smoke has been entirely eliminated and the saving in fuel exceeds the guarantee made by the Company. For further particulars, circulars, testimonials, prices, etc., address Hughes Smoke and Spark Preventer Co., 503 North Sixth Street, Philadelphia, Pa.

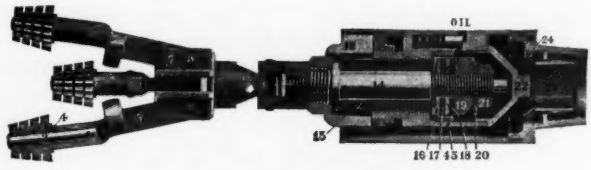
The "Liberty" Water Tube Cleaner.

Considering the fact that the scale formed inside the water tubes of a boiler is sometimes harder than the hardest stone, any device which is capable of removing it without injuring the boiler tubes, must be looked upon not only as an ingenious device but also as a necessity to those whose boiler tubes are coated with this heat-repelling substance.

Several years ago, the Chicago Boiler Cleaner Co. brought out an excellent turbine cleaner; then the "Niagara" cleaner came and met with considerable success. Finally, both of these cleaners were acquired by the Liberty Mfg. Co., 6907 Susquehanna Street, Pittsburg, Pa., by whom they are still being manufactured. Now, this same Company have brought out still another cleaner which is specially designed for very heavy work. It is known as the "Liberty." This machine consists of a powerful water turbine which drives a cutting head, in which are mounted freely swinging arms. The centrifugal force due to the high rotary speed of the machine causes these arms to fly out like governor balls on an engine. On the free ends of the arms are mounted rotativing cutting wheels which strike the scale and produce a combined roller, cutting, hammer and drill action which removes the scale.

This same principle is also used in "Niagara" and "Chicago" turbine water tube cleaners manufactured by the same firm, but while the two latter cleaners have stationary shafts upon which ball bearings are mounted and around which the turbine wheel revolves, the "Liberty" machine does not have ball bearing. A peculiarly constructed bearing resembling a thrust bearing is used which is said to possess advantages over the ball-bearing arrangement for heavy work.

The "Liberty" cleaner is adapted for heavy scale, as the motors are powerful, and special attachments can be applied. When the scale exceeds ¼-inch in thickness, or is of a very hard nature, the freely swinging arm head is removed and a peculiarly shaped drill is attached to a universal coupling which is inserted between the motor and cutting tool and whose function is explained later. With this arrangement, tubes can be cleaned that are entirely filled up with scale.



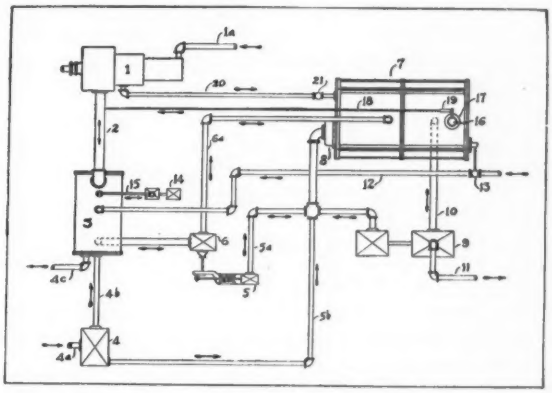
Liberty Water Tube Cleaner.

In operating the cleaner, a water connection is made through a hose connecting the water supply with the cleaner. The cleaner is inserted in the tube, the water turned on, and the operator grasping the hose feeds it gradually into the tube as fast as the scale is removed. The sound of the tool cutting in the tube will determine how fast it should be fed. For heavy scale, the cleaner is equipped with a universal coupling which connects the cutting tool with the turbine. This flexible connection relieves the machines from the shock, which prolongs the life of the wearing parts adapts the machine to cleaning bent tube boilers.

The cleaners are made in sizes to clean tubes from 1½ inches in diameter to any size required and can be used on all kinds of industrial tubes in which there is incrustation on the inner side of the tube.

Auxiliary Equipment in Steam Turbine Plants.

Among the new problems and opportunities presented by the recent commercial development of the steam turbine is the application of the auxiliary equipment in plants operated by turbines. The Harrison Safety Boiler Works, of Philadelphia, have given special atention to the adaptation of their Cochrane Feed Water Heaters to such plants and they have developed some features in these installations which should prove of considerable interest to engineers.



Method for Heating and Regulating the Boiler Feed Water in Steam Turbine Condensing Plants.

The accompanying illustration shows an approved method, designed by the Harrison Safety Boilers Works and covered by letters-patent, for heating and regulating the boiler feed water and is particularly adapted to plants where the steam turbines are operated in connection with surface condensers, although this method is also applicable to plants where surface condensers are used in connection with reciprocating engines.

1 is the main steam turbine taking steam through the pipe *1a* from the boiler. *2* is the exhaust pipe from the turbine to condenser. *3* is the surface condenser receiving the exhaust from *2*. *4* is a pump taking cold water through suction pipe *4a* and forcing it through pipe *4b* into the condenser to condense the exhaust steam therein; *4c* is the discharge for the circulating water from the condenser. *5* is an auxiliary engine driving a pump *6* for drawing the condensation of the steam from the condenser and delivering it to the open heater through the pipe *6a*. *5a* is the exhaust pipe from this auxiliary engine joining the exhaust *5b* from *4*. *7* is a Cochrane Feed Water Heater receiving the exhaust from the auxiliaries through the oil separator *8*. *9* is a pump taking the feed water from the heater through the pipe *10* and discharging it to the boilers through the pipe *11*. The exhaust from this pump, joining the other auxiliary exhaust, enters the separator *8*. *12* is the supplementary cold water feed supply emptying into the condenser *3* to make up any difference between the quantity of the condensation of the steam and the amount of water required by the boilers. The supplementary water is controlled by the valve *13* according to the level of the water in the heater *7*. This valve is automatically closed or opened by the float and connecting mechanism. *14* is an air pump exhausting air from the condenser *3* through the pipe *15*. In cases where this pump is steam driven, the exhaust also enters the separator *8*.

With The Engineers' Societies

Old Colony Council.

The new officers of Old Colony Council, No. 14, A. O. S. E., of Rockland, Mass., were publicly installed on Thursday evening, January 5th, and the installation ceremonies were followed by a turkey supper for the members and their wives and friends, all of which contributed to the passing of a very pleasant evening. The installation ceremonies were conducted by Past Chief Engineer Herbert W. Jones, assisted by Past Chief Chas. W. Alden. The new officers follow: Chief Engineer, Joseph Bryant; Assistant, Francis Caldwell; Recording and Corresponding Engineer, Walter N. Randall; Financial and Treasurer Engineer, Charles Scott; Chaplain, Edw. H. Naylor; Senior M. M., James K. Sedgwick; Junior M. M., Donald Inglie; Inside Sentinel, Frank Bosworth; Outside Sentinel, H. H. Lawler; Past Chief, Thos. W. Sharp.

North-east Association.

Mr. Wiltsie F. Wolfe, member of the American Society of Heating and Ventilating Engineers, delivered an interesting and very instructive lecture before North-east Association, No. 20, N. A. S. E., of Philadelphia, in their rooms at the N. W. Corner of Kensington Avenue and E Street, on Wednesday evening, January 11th. Despite the inclemency of the weather, the halls were crowded to the doors, and the audience showed their thorough appreciation of the lecture, the subject of which was "Heating and Ventilation of Public Buildings." This is only one of the many interesting events that have been given by North-east Association during the past year and we understand that arrangements have been made for several more lectures on topics of special interest to engineers by some of the best qualified experts in their respective lines. Meetings are held every Wednesday evening at the address given above.

Cement Council.

The newly-elected officers of Cement Council, No. 23, A. O. S. E., of Northampton, Pa., are as follows: Chief Engineer, C. A. Smith; Assistant, Morris Moyer; Recording and Corresponding Engineer, J. H. Hess, Catasauqua, Pa.; Treasurer, W. H. Thomas; Financial Engineer, Reuben Ott; Senior M. M., E. L. Hartman; Junior M. M., F. C. Fogel; Sentinels, E. D. Reinert and Joseph Boyle; Chaplain, Albert Baader; Trustee for eighteen months, Chas. E. Silfies; Delegates, B. C. Wilson and W. J. Patrick. Cement Council is doing nicely. They expect to have close to a hundred members before they celebrate their first anniversary.

Kensington Council.

Owing to the approval and evident appreciation of their several lectures given last winter, Kensington Council, No. 3, A. O. S. E., of Philadelphia, are giving another very interesting series of lectures this winter. The dates and subjects of the remaining lectures are as follows: Thursday evening, February 2nd, "Boiler Feeding Appliances"; March 2nd, "Electricity"; April 6th, "The Indicator"; May 4th, "Hydraulic Elevators." No admission is charged to these lectures, but, on the contrary, all engineers are cordially invited to attend. All lectures are illustrated with stereopticon views or blackboard drawings and the lectures are delivered by men who are thorough masters of their subjects. Two of the present series of lectures have already been given, and we advise every Philadelphia engineer who can do so to attend the remaining ones.

Lehigh Council.

The members of Lehigh Council, No. 15, A. O. S. E., Allentown, Pa., and their friends, enjoyed an oyster supper on Saturday evening, January 7th. There was a large crowd present despite the fact that it was a cold night and as is usual with the Allentown boys they made things hum. It is a matter for genuine regret that more of the engineers' societies of the country are not endowed with the large degree of cordial goodfellowship and hustling enterprise that has brought Lehigh Council so rapidly to the front in the last four years.

Atlantic City Council.

A grand banquet in honor of their eighth "birthday" was given by Atlantic City Council, No. 4, A. O. S. E., on Saturday evening, January 7th. The affair was held at the Hotel Central, the large banquet hall of which was handsomely decorated for the occasion. There were some two hundred members and guests present and a most delightful evening was spent by all. The banquet followed the installation of the new officers, the ceremonies for which were conducted by Deputy Supreme Chief, Joseph Whitley, assisted by H. R. Talliaferra, of Camden. There were many visiting brothers present, among whom were Past Supreme Chief, F. R. Moore; Supreme Treasurer, Geo. Richardson, Joseph High, Frank Mellor, Thos. Marshall, Harry Young, John Martin, John Boyce, and T. D. Just. There were also a number of old friends representing various supply houses: Jenkins' Bros. were represented by the two McHughs; the Garlock Packing Co. by B. J. Miller and H. Brady; O. F. Zurn Co. were represented by Charlie Curren, who is an old-time favorite in the City-by-the-Sea; Captain Doughty represented the Geo. W. Lord Co., and Charlie Hopper represented the Keystone Lubricating Co. John R. Livezey, of Nonpareil Cork fame was on hand, debonair and smiling as usual. It was Livezey who laid down the "rules," and each "rule" bears the name of Nonpareil Cork. All of the visitors remained in Atlantic City over night and it is hardly necessary to say that there was a jolly time.

The new officers of the Council are as follows: Chief Engineer, Ira Hardin; Assistant, Edw. Meloney; Recording Engineer, W. S. Price, Haddon Hall; Financial Engineer, C. F. Noble; Treasurer, R. S. Petersen; Chaplain, Warren Morris; Senior M. M., J. W. Frampton; Junior M. M., Frank Atkinson; Sentinels, G. B. Colescott and J. A. Best; Trustee, Warren Morris.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

Well, boys, I'm still holding down my job as editor of Trade Notes, but I'm only on probation, you know; just like you sometimes "try out" a new boiler compound, a fuel-saving device or a new style of packing. I was put here for the purpose of helping to bring engineers and the manufacturers of power plant equipment and supplies closer together, and I must either make good or go "back to Missouri."

Several good fellows have written me telling me of prospective customers for engines and other equipment and supplies, all of which I appreciate greatly, but some others have written quite differently. One engineer out in Wisconsin refers to me as "that conceited chump"; another one from California says: "That ad. mgr. of yours ought to go back and shovel coal"; another, from New York State, says: "That advertising manager is entirely too fly." Perhaps he means I am a bird of an editor. But they were not all "knocks," for W. H. Wakeman referred to me as "the genial advertising manager." Now that's decent, isn't it? In the future you can put me down as being in favor of a wrench for closing valves.

P. S.—The chief editor has just remarked that I'll need a wrench to shut off the hot air connection. So here goes.

How would you like to be Mr. Moore? On January 9, Mr. Henry S. Manning sold his entire interest in the firm of Manning, Maxwell & Moore, together with his interest in the Ashcroft Mfg. Co.,Consolidated Safety Valve Co., Hayden & Derby Mfg. Co., and the Hancock Inspirator Co. to his long time business associate, Mr. C. A. Moore. There will be no change in the name or character of the firm of Manning, Maxwell & Moore, and its business in the future will be conducted by Mr. Moore and the other gentlemen who have been associated with him. The main offices will remain as they are in the handsome large building at 87 Liberty street, New York. This business was started in 1871 under the firm name of H. S. Manning & Co. In 1881 it was succeeded by Maxwell, Manning & Moore. The business grew and prospered, and various other manufacturing industries were acquired until it became of large magnitude. The firm now have branch houses in Philadelphia, Chicago, Boston, Pittsburg, Cleveland and St. Louis. Mr. Manning retired from the firm because of his desire to be relieved of all business cares.

Did you get a calendar for 1905 from the Dearborn Drug and Chemical Works of Chicago. If you want one that you can see without "specs," it's just the trick; for like everything else issued by the Dearborn people, it's on a large scale. I've just returned from measuring it; it's 21 x 28 inches, is printed in two colors, and is made to hang on the wall. If you want one, drop a postal card to any Dearborn man that you happen to know, or to the main office, Rialto Building, Chicago.

The Shepherd Engineering Co., of Franklin, Pa., have been awarded the gold medal for their engines by the Philippine Government Board at the Louisiana Purchase Exposition, for their excellency of design, workmanship and operation. During the Exposition the Shepherd Company had three of their engines, two simple and one compound, in service at the power house of the Philippine Exposition. A complete description of these engines will be sent upon application to those interested.

The Buckeye Boiler Skimmer Co., Toledo, Ohio, have received the following interesting letter from the Groton Milling Co., of Groton, S. D.:

Gentlemen:—Replying to yours of the 15th, regarding boiler skimmer purchased from you some three months ago, will say that we are greatly pleased with it, and consider it one of the best investments we ever made. It does all you claim for it and more. In a week's run, day and night, we do not find a cupful of mud in our boiler. The old scale is dropping off and no new scale forming. Could we not replace our skimmer we would not sell it for double the money it cost us. Groton Milling Co., per A. McKiver, Mgr.

Any of our readers who are interested in Feed-Water Heaters or Power Pumps should send for the catalogues of I. B. Davis & Son, Hartford, Conn.

FORM A MODEL

LIBRARY

WE have a list of 25 books covering 25 popular mechanical and electrical subjects.

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Spon & Chamberlain

Publishers of Books for Engineers

Department P. E., Liberty Building

NEW YORK, U. S. A.

Our friends, the Lagonda Mfg. Co., of Springfield, Ohio, send us a most encouraging report for the commencement of the new year, 1905.

They tell us that the last year has been the most prosperous in all their history, and last month, December, was the largest single month's business they have ever recorded, and last Saturday, the last working day of the month, they shipped more goods than in any one day since they commenced business. They are considerably behind orders, and are running their factory until 9 at night. This, certainly, is a very encouraging report, and we congratulate the Lagonda people. They are manufacturers of the famous Weinland Tube Cleaners, Tube Cutters, Damper Regulators and other steam specialties, which are advertised from time to time in our columns.

John R. Livezey, the pipe covering expert, 1936 Sansom street, Philadelphia, has closed some large contracts recently, among them being all the steam and brine pipe covering for the Hershey Chocolate Co. at Derry Church, Pa. He has also furnished and erected their cold storage rooms, in which is used two 35-ton refrigerating machines. He also has contracts for a large amount of cold storage work in Baltimore as soon as it is ready. The large contract at the Bellevue-Stratford Hotel is near completion. Mr. Livezey has estimated on cold storage work to the extent of nearly a hundred thousand dollars, all to be done in the near future. Among the local contracts already in hand for ice water and brine pipes in Philadelphia are the University Club, Lit Brothers, Snellenburg's, Majestic Apartments, Bingham House and Union Ice Co. Mr. Livezey has also been given a contract for the complete insulation of the new plant for Swift & Co. at Allegheny, Pa., also a new brewery in Ohio, and the complete insulation of the new stock house of the Anheuser-Busch Brewing Association of St. Louis. This contract will require 400,000 square feet of sheet cork.

Engineers often find it convenient to consult tables, statistics or data relative to special features of their work. The facts of every-day experience cannot all be carried in the head, and the engineer who makes this effort often finds himself at sea regarding some specific point.

To everyone in the engine room—no matter what his experience—the little booklet of the Cancos Manufacturing Co., of Philadelphia, Pa., will come as a valuable assistant. From cover to cover it is filled with strong, terse, helpful matter in condensed form—tables, statistics, data, information—all practical, all helpful, and all time saving.

As an aid to the memory of even the most experienced, this little book—free for the asking—should be on every engineer's work-desk. Of course, it mentions Cancos Packing, sets forth briefly its advantages in cost, efficiency and length of service; but apart from this it is

well worth while as a useful little compendium of every-day knowledge. Of necessity the edition is limited, but while it lasts, the Cancos Manufacturing Co., of 146 North Second street, Philadelphia, Pa., will send a copy to any engineer who forwards his address. Mention The Practical Engineer when writing.

Cadman's Aluminum Babbitt Metal is probably the best bearing metal made anywhere in the world at any price. It contains neither lead nor zinc and weighs but 4.2 ounces per cubic inch. It is manufactured by A. W. Cadman Mfg. Co., 2824 Smallman St., Pittsburg, Pa.

H. B. Underwood & Co., general machinists, 1025 Hamilton street, Philadelphia, are putting out a handsome new calendar for 1905, one of which they will send to any engineer who has not already received one. Incidentally, I might mention that the Underwood people are building another addition to their shops. They have made so many improvements during the past year or so that there is no more vacant ground around them, so this time they are going up in the air, adding more stories, you know. This firm make a specialty of engine and pump repairs; they send portable tools and expert workmen to any part of the country. Their reputation for excellence, like their shops, continues to grow apace.

H. B. Wilson & Co., 747 F street, Washington, D. C., issue a little book which tells how to obtain patents and a lot of other useful information which will interest any one of an inventive turn of mind. A copy will be mailed free upon request.

Messrs. Adam Cook's Sons, 313 West street, New York city, the only makers of Albany Grease, are in receipt of a letter from C. F. Miller, superintendent of ice department, Sparta Gas & Electric Co., Sparta, Ill., in which he states that they have tested this well-known lubricant and find it much the best they have ever used. Mr. Miller adds, "We would like very much if we could use cups on all of our bearings, as the Albany Grease lasts so long and saves so much trouble in oiling." Messrs. Adam Cook's Sons offer to send a sample of Albany Grease and an Albany Cup free of charge to engineers for testing, and we would advise those among our readers who have not done so to apply for same.

Every engineer knows the value of a quick-closing water gauge and of a leakless gauge cock, but not all engineers know how much they cost or where to get them. They are made by Paul B. Huyette, 1245 Betz Building, Philadelphia. A circular will be sent by Mr. Huyette upon request.

Messrs. Spon & Chamberlain, 123 Liberty street, New York city, have just ready an important new book by J. H. Kinealy, M. Am. Soc. M. E., on the design and construction of Centrifugal Fans, fully illustrated from original drawings with many formulæ and tables. This is the most comprehensive treatise on this important subject ever published, and will prove of great value to draughtsmen and all engineers interested in fan efficiencies. During the many years Messrs. Spon & Chamberlain have been publishing high class technical books, their dealings have been uniformly fair and liberal, and our readers will find it both pleasant and profitable to do business with them.

Yes, "silence is golden," but it's sixteen to one that silence is away from home when the pump is out of order. M. T. Davidson, 141 Broadway, New York city, knows pump troubles from A to Z, and he also knows how to avoid them. Write him for circular.

The Diamond Drill & Machine Co., of Birdsboro, Pa., announce their having opened a New York office at 52 Broadway. They also state that both their steel and iron foundries are more rushed than at any time during the past year, while their machine shop is running double time, with enough orders ahead to keep up same condition for months to come, being especially busy on rolling mill and blast furnace work. Another specialty, the Jackson Belt Lacing Machine, has been in such demand that the department also has been taxed to its utmost during the past year, and the outlook is most promising.

He ought to look on page 64

"Where in the divil is my pipe?"

For nine years Sweet's Separators have been on the market, and during that time more than 3,500 of them have been sold and are now in use. They are made in all styles and shapes, and there is no corner in or around an engine that they cannot be made to fit. The successful operation and satisfaction that they have given can best be illustrated by the fact that over 50 per cent. of all sold during the past six years have been on repeated or duplicated orders.

They are manufactured by the Direct Separator Co., of Syracuse, N. Y., who are also makers of Sweet's Exhaust Heads and Powers' Steam Traps. They will gladly send blue prints, showing all detail, reports of various tests and lists of users to any one mentioning The Practical Engineer.

An interesting "bunch" of specialties are shown in a folding circular sent out by L. B. Mellor, 14 South Fourth street, Philadelphia. They include several different kinds of boiler tube and flue cleaners, a loose pulley lubricator, the Gem patent oiler, a plain Gem oiler, and some Gem torches. If you are interested in any of these, better send a postal to Mellor and get a circular.

Sterling Compound is a new boiler compound said to possess wonderful power and to be entirely free from any substance that can injure metal in any way. It is claimed that it will effectually prevent the formation of scale or remove the most obstinate old scale. It is sold on approval, and a sample will be sent free to any one interested. The Sterling Compound Co., Lawndale, Philadelphia, are the makers.

If you are interested in the Hughes Smoke and Spark Preventer described elsewhere in this issue, write to 503 North Sixth street, Philadelphia, for illustrated circular.

As usual, the 1905 calendar issued by the Kutztown Foundry & Machine Co., 116 North Broad street, Philadelphia, is the most beautiful and elaborate one that has reached our office, and again, as usual, the demand for it has been so great that the edition is entirely exhausted. However, the company have decided to issue a new monthly calendar which they will be pleased to mail to engineers upon request.

An appropriate calendar for Western engineers has just been received from Chas. C. Moore & Co., of San Francisco. It consists of a nicely colored map of the Pacific Coast and extending east to Colorado. We presume that a copy will be sent to our Coast readers upon request. Messrs. Moore & Co. are well known engineers and machinery dealers, with branches in Los Angeles, Seattle and Salt Lake. Their specialty is the contracting of complete power plants, they having erected and furnished many of the largest and most important plants on the Pacific Coast.

Tulley's Hand Book on Engineering is described in detail in a 40-page booklet being sent out by the author. This booklet tells just what is to be found in Tulley's book, and tells it in comprehensive language. A copy will be mailed you free upon request. Address Henry C. Tulley, Room 12, Wainwright Building, St. Louis, Mo.